505. S4a

SCIENTIFIC AMERICAN SUPPLEMENT

Scientific American Supplement, Vol. I., No. 2.
Scientific American, established 1845.
New Series, Vol. XXXIV., No. 2.

NEW-YORK, JANUARY 8, 1876.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.
Postage free to Subscribers.

ON THE CAUSES OF KNOCKING IN HIGH-PRESSURE ENGINES.

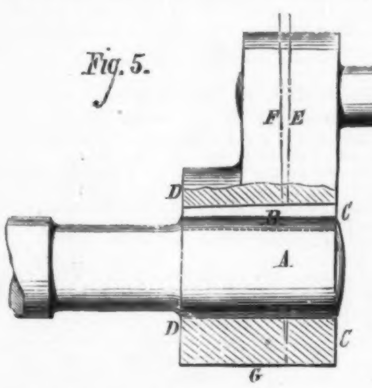
By Joshua Rose.

[Concluded from page 1.]

In some cases the crank-pin may stand practically true with the hole in the crank, and the main-shaft may be lined true with the bore of the cylinder, and yet the connecting-rod applied as a test (as before described) may disclose that the crank-pin does not stand at a right angle to the bore of the cylinder, the effect being the same as though the hole for the crank-pin had not been bored parallel with the hole in the crank which receives the main-shaft, the causes of which are to be looked for in the method of fastening the crank to the main-shaft.

If the part of the main-shaft on which the crank fits is tapered to the slightest degree, the crank should be made with a corresponding taper in the hole; otherwise, when the crank is upon its place, it will fit at one end only, and driving in the key, which locks the crank to the shaft, will in all probability strain the crank out of true. Suppose, for instance, that in Fig. 5, which represents a crank main-shaft and key,

Fig. 5.



the crank fitted the shaft closely at and towards the end D D, but was not so perfect a fit at and towards the end C C, then driving the key B would set the crank over so that its centre line (before being keyed up) E would stand at F when the key was driven home, especially if the key chanced to fit the closest at the end C. The natural tendency of the metal in the crank is to give way the most at the under side, G, because the crank is the weakest there.

If the crank is made to be put on by hydraulic pressure, it is equally as important that it should fit the shaft equally from end to end, otherwise it will set over as described, especially if it should be a little tight to its place, in which case the metal at G would be apt to give way. The difficulty of boring a slightly conical hole to fit a taper shaft when the two can not be easily handled to try them in fitting, and the almost impossibility of detecting in such large work any slight incorrectness in the taper, render it advisable to make the end of the shaft and the hole in the crank as parallel as practicable. And if with these precautions the proper amount of *and not too much allowance* is made for forcing over by the hydraulic ram, the crank will go to its place true, and is not at all apt to be sprung by the key, even though the latter should not bind equally from end to end of its length.

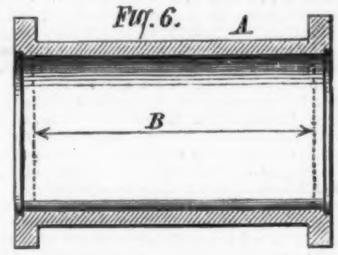
If it is intended to contract or shrink the crank to its place, but very little allowance should be made for shrinkage, otherwise the metal at the end G of the crank will give way, and will tend to increase the length of the crank, if it is of wrought-iron, and to split it at G if it is of cast-iron. Furthermore, the crank will be apt to give way more at the end that is hottest than where it is coolest, which would throw it, and consequently the crank-pin, out of true. Just as much care should be taken to make the hole in the crank and its bed upon the main-shaft quite parallel when it is intended to shrink on the crank, as though it were to be made a driving fit only, because the metal in shrinking is sure to give way the most in the weakest place, and at that part of the same which is hottest; to obviate which the amount allowed for shrinkage should not be more than, for a six-inch shaft, the $\frac{1}{100}$ of an inch, or an amount which is barely perceptible by careful usage of the callipers, the latter being set so as to merely appreciably touch the work, and therefore not to spring at all, as they will if allowed to touch heavily.

Whether the crank beds evenly upon the shaft or not, the key should be carefully fitted to bed upon the key-seats in the crank and upon the shaft, from end to end.

Another and not infrequent cause of knocking is, that the crank-pin and the cross-head journal wear oval, for the reason that they are not subject to much wear when the engine is on or near either of the dead centres; this cause, however, is mainly confined to the cross-head journal, especially in those cases in which the cross-head guide-blocks and cross-head journal are of cast-iron and in one piece. The remedy of course is, in this case, to file off the protruding parts, in which case it is well to ease them off a little below the proper curve, which plan should always be adopted in fitting them up when new.

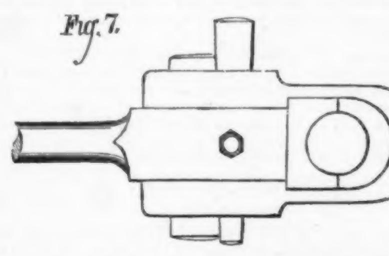
When an engine that has run for a long time suddenly commences to knock, the cause in many cases will be found to be that the piston-head or follower strikes against a projection at either or both ends of the bore of the cylinder, which projections are due to the wear of the bore of the cylinder (and there may possibly be similar projections at each end of the guide-bars). Thus, in Fig. 6, suppose it to be a cylinder, and the stroke of the piston therein, when the

Fig. 6.



engine is new, to be denoted by the line B, there will be therefore a short piece of each end of the bore of the cylinder over which the piston does not pass, and which does not therefore abrade or wear away, so that, in the course of time, there will be left a projection at each end of the cylinder. It is usual, it is true, to counterbore each end of the cylinder; but in time the cylinder-bore wears below the counterboring (or recesses), and even were such not the case, the ridge would still form, because the connecting-rod wears longer or shorter according to the form of its construction. For instance, if the rod has both its straps held to it by jibs and keys only, as shown in Fig. 7, it will wear shorter from cen-

Fig. 7.

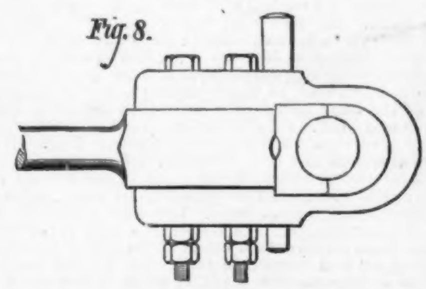


tre to centre of the bore of the brasses, the straps passing farther up the block-ends of the rod as the brasses wear and let the key down.

The natural consequence of the rod wearing shorter is, that the position of the stroke of the piston in the cylinder gradually alters, approaching the cylinder-cover nearest to the crank, and receding from the cylinder-cover opposite. If, therefore, the counterboring was made to come just fair with the ends of the piston-stroke at first, there would form a ridge at the end of the cylinder farthest from the crank.

A connecting-rod whose cross-head end has a strap secured by a jib and key, as shown in the above figure (as is usually the case at that end), and whose crank-pin end has its strap secured to the rod-end by bolts, as shown in Fig. 8, the key

Fig. 8.

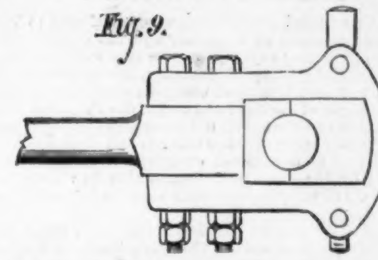


being located between the bolts and the brasses, would maintain its original length, notwithstanding the wear, provided that the latter was as great at the cross-head as it is at the crank-pin end of the rod. Since, however, such is not the case, such a rod wears longer to half the amount of the difference in the wear of the respective brasses, the result being that as the rod-brasses wear, the stroke of the piston in the cylinder approaches the cylinder-cover farthest from the crank, and recedes to a like amount from the opposite cylinder-cover, and hence the ridge will, in this case, form at the end of the cylinder nearest to the crank. And the same remarks apply to a rod having both straps secured to the rod ends by bolts, one strap having the key between the bolts and the brasses, as shown in Fig. 8, and the other strap having the key located between the brasses and the crown of the strap, as shown in Fig. 9.

This latter form of rod is, however, preferable to the others, in consequence of the firmness with which the straps are locked to the rod-ends.

The formation of the ridge referred to will, it is true, be very gradual, but it must be borne in mind that when the connecting-rod brasses have become so much worn that the key has passed through the rod or strap, as the case may be, and it hence becomes necessary to place liners behind the brasses to set the key back again, the machinist regulates the thickness of the liner on each side of the brasses, so as to

Fig. 9.



bring back the distance from centre to centre of their bores to the original length; which of course brings back the stroke of the piston to its original position in the cylinder, and if, therefore, there be a ridge at either end of the cylinder-bore, the piston strikes against it, and thus causes a knock. It is obvious that as the position of the piston-stroke in the cylinder alters, so will the position of the stroke of the guide or motion-blocks alter in the guide or motion-bars, and that a ridge will also form at their ends. To remedy these defects in both cases, it would be a good plan to make the distance of the recesses at the ends of the cylinder-bore, and at the ends of the guide or motion-bars, shorter than is the stroke of the engine, to an amount about equal to the amount of taper allowed on the connecting-rod keys, so that even when the wear of the connecting-rod brasses has let the keys down, both the piston and the guide or motion-blocks will still travel over the recesses at each end of the stroke. It would appear that since the movement (by wear) of the key is not more than half that of its length, an amount equal to half the taper of the key would suffice; but it must be borne in mind that a quarter of an inch of difference in the length of the rod alters the position of the stroke of the piston in the cylinder $\frac{1}{8}$ inch at each end, or $\frac{1}{4}$ inch in all.

When an engine knocks, the location of the knock may be ascertained as follows: Take a piece of iron wire, or any slight body, such as a lead-pencil, and place one end on an end of the cylinder, taking the other end between your teeth; then pass to the other end of the cylinder—to the steam-chest, guide-bars, and bearings of the main-shaft, repeating the operation in each place, and the sense of feeling will distinctly indicate the location of the knock by imparting a more severe shock to the teeth when the vicinity of the knock is approached.

THE ROYAL ALBERT BRIDGE.

Mr. Legge, Civil Engineer, and staff, are engaged preparing plans of the proposed bridge which is to span the St. Lawrence at Montreal, with St. Helen's Island as a stepping-stone.

The *Witness* says: "Leaving the level of the ground at Sherbrooke street, it is carried as a viaduct east of Colborne avenue, at a level of ninety feet above the surface of the ground, in spans ranging from 150 to 200 feet each, striking the navigable channel of the river St. Lawrence near Molson's brewery. It passes over to St. Helen's Island by means of six spans. The main span over the navigable channel of the river will be from 500 to 600 feet in the clear, at the height of 130 feet above summer level of the water in the harbor, or 120 feet above ordinary winter level (being the height of the Britannia bridge above mean tide level, as determined by the British Admiralty as a suitable height for navigation purposes). The remaining spans over this channel will be five in number, each 300 feet in the clear, carried on same level to the north shore of St. Helen's Island, from which point four spans of 240 feet each will be built, striking the natural surface of the ground on St. Helen's Island near its highest point, where this portion of the bridge proper terminates. From the south side of St. Helen's Island a second bridge will be carried over the unnavigable channel, striking the south shore with 21 spans of 200 feet each; from the south shore the bridge is continued as a viaduct with five spans of 200 feet each, until it meets the embankment leading up to the Grand Trunk and the Montreal and Chambly Railways. The total length of the bridge and viaduct will be fifteen thousand five hundred feet, and the extreme distance from point of departure on the Montreal, Ottawa, and Western Railway on the Mile End heights, near Sherbrooke street, to the point of intersection with the Grand Trunk and Montreal and Chambly Railways, will be about five and a half miles."

M. Edlund gives (Poggendorff, No. 10, 1875) an experimental demonstration that galvanic resistance is affected by the motion of the conductor. He made a current pass, in two opposite directions from the middle part of a tube, through water that was sent through the tube; and with a galvanometer proved that the resistance was less where the galvanic current went *with* the liquid one. There is another electrical paper, in which Dr. Bleekrode recommends ebonite as preferable to glass in many ways for the disks of "electro-machines."

Scientific American Supplement.

No. 2.

FOR THE WEEK ENDING JANUARY 8, 1876.

PUBLISHED WEEKLY,
AT THE
OFFICE OF THE SCIENTIFIC AMERICAN,
No. 37 Park Row, New-York.
MUNN & CO., Editors and Proprietors.
O. D. MUNN. A. E. BEACH.

The SCIENTIFIC AMERICAN SUPPLEMENT is uniform in size with the *Scientific American*. Terms of subscription for SUPPLEMENT, $5.00 a year, postage paid, to subscribers. Single copies, 10 cents. Sold by all newsdealers throughout the country.

COMBINED RATES.

The *Scientific American* and SCIENTIFIC AMERICAN SUPPLEMENT will be sent together for one year, postage free, to subscribers, on receipt of $7.00.

Remit by postal order. Address,
MUNN & CO., PUBLISHERS,
37 Park Row, New-York.

OFFICIAL INSPECTION OF THE EXHIBITION BUILDINGS AND GROUNDS.

SINCE the national government was transferred to Washington three quarters of a century ago, the ancient capital has seen no gathering to compare with that which assembled on the Centennial grounds on Saturday, December 18th. The greater part of both Houses of Congress were there, a majority of the judges of the Supreme Court, the President and several members of his cabinet, the governors of several States, and an imposing array of other officials and dignitaries.

The object was a personal examination of the work accomplished by the Centennial Commission, in view of their appeal for aid in carrying out their work to successful completion.

Believing that the most effective argument in behalf of the Commission's work would be the work itself, an invitation had been given to the representatives of the nation at Washington to come and see it before deciding whether to grant the appropriation called for—the city of Philadelphia generously acting the part of host, and paying the costs out of a fund subscribed for the purpose by the business men of the city. The visitors were conveyed from Washington in a double train of fifteen cars, and spent the day in a thorough investigation of the buildings and grounds, winding up with a discussion of the merits and prospects of the Exhibition (and dinner) in the Horticultural Hall.

The influence of the visit seemed to be all that could have been desired. The indifference of many was changed to positive enthusiasm, and on all sides the opinion was frankly expressed that the Exhibition was well worthy of the assistance asked for. And more than that, a realizing sense of the national character and importance of the undertaking was aroused in the representatives of every part of the country, who will take pains to explain its workings to their constituents, and in every way exert themselves to see that the industries of their respective States are fully represented.

After dinner, the presiding officer, Mr. John C. Bullitt, delivered an address on the magnitude, cost, and condition of the Exhibition enterprise. In addition to information already before the readers of the SUPPLEMENT, he gave the following comparative statement of the dimensions and cost of the great World's Fairs already held :

	Space Covered.	Cost.
London, 1851	20 acres.	$1,464,000
New-York, 1853	5¾ acres.	500,000
Paris, 1855	30 acres.	4,000,000
London, 1862	24 acres.	2,300,000
Paris, 1867	40½ acres.	4,596,763
Vienna, 1873	50 acres.	9,850,000
Philadelphia, 1876	60 acres.	6,724,350

The great interest taken by foreign nations in the Centennial show is manifested by the amount of space which they have taken :

	Total area of building.	Foreign space.
Main Building	21.47	12.4
Art Building (to be increased).	1.50	over 80 per ct.
Machinery Hall	14.00	about 25 per ct.
Horticultural Hall	1.50	1.7
Agricultural Hall	14.15	1.3

In addition, special buildings have been or will be erected by eleven countries, to wit : Great Britain, 3; Japan, 3 ; Sweden, 2 ; Spain, 2 ; Egypt, 2, and Germany, Brazil, Canada, Australia, Turkey, and Morocco, one each : in all, eighteen buildings.

So far as heard from, appropriations for Centennial purposes have been made by foreign governments as follows :

Great Britain, with Australia and Canada (gold)	$250,000	Sweden	$125,000
France and Algeria	120,000	Norway	44,000
Germany	171,000	Chili [Owner of all goods exhibited and all expenses.]	....
Austria	75,000	Venezuela [All expenses, am't unlimited.]	....
Italy (Government, $38,000 ; Chamber of Commerce, $38,000)	76,000	Ecuador	10,000
Spain	150,000	Argentine Confederation [Owner of all goods exhibited.]	60,000
Japan	600,000		
Belgium	40,000		
Denmark (gold)	10,500		

In the course of his address, Mr. Bullitt took pains to refute the too prevalent impression that the Exhibition is a private enterprise, at most an affair of the State of Pennsylvania—not a matter of national concern, to the success of which the nation can appropriately contribute. "It is," he said, "the property of the whole nation. It had its origin in laws of the United States. It has been conducted under its auspices thus far, and whatever of prestige or success may attend it must be due to and inure to the credit and honor of the United States. I have said it was the property of the whole nation, and I use those words in the broadest and most catholic sense. National in its conception, in its creation, in its progress, in its purposes and objects, in the spirit which has pervaded the efforts of those who have had it in charge, in the magnitude of its proportions, in its softening and harmonizing influences upon our own people ; national in its relations to foreign powers, to the several States, and to the government of the United States, there is and can be no proprietary ownership in it or of it, save and except that of the 40,000,000 of free people for whom and on whose behalf this grand Exhibition is being prepared. But not only is it national : it gains additional lustre from the fact that its every object and purpose are in the interests of peace—in the appropriate words of the President's Proclamation of July 3d, 1873, 'in the interest of peace, civilization, and domestic and international friendship and intercourse'—peace abroad and at home—peace and good-will with foreign powers and among our own countrymen."

THE MACHINERY HALL OF THE INTERNATIONAL EXHIBITION.

[See page 24.]

WE take from the *Leipziger Illustrirten Zeitung* an inside view of the Machinery Hall for the Centennial Exhibition. This hall, which is the second largest of the buildings erected for the Exhibition, is situated west of the intersection of Belmont and Elm Avenues, distant 542 feet from the west side of the main Exhibition Building, and 274 feet from the north side of Elm Avenue. As the north front of the Machinery Hall is in line with that of the main building, the imposing front of 3824 feet of buildings will be presented to the spectator.

The Machinery Hall consists of a main section, 360 feet wide and 1402 feet long, together with an extension at the south side of 210 feet length and 208 feet width. The area covered is 558,440 square feet, or $12\frac{82}{100}$ acres, but the entire available area amounts to nearly 14 acres. The main section of the hall has the height of one story, the main cornice being 40 feet from the floor, while the clear height of the main passages is 70 feet, of the side sections 40 feet. The long outlines of the building are varied by projecting corners and ornamental fronts of the main entrances, which are 78 feet high. The main entrance for wagons from the main building and railroad depot is at the east side. The south side is intended for exhibition of boilers of all kinds and machines of special construction, while the west side offers the opportunity of a direct access to George's Hill, from which the whole area taken up by the Exhibition Buildings may be overlooked.

Two main avenues, 90 feet wide and about 1360 feet long, run through the hall, and are connected with narrower passages in the centre of the building and at both sides. A passage of 90 feet width and 208 feet length crosses the main avenues and leads to an extension for hydraulic machines. The foot-passages of the main avenues are 15 feet wide, those in the side-passages 10, and in the crossway 25 feet. All other crossways of the hall are 10 feet wide and connect with exit-doors at the ends.

The foundations are made of brick and stone pillars, the superstructure of strong timber-supports, which carry the iron construction of the roof. The columns, that are arranged at a distance of 16 feet from each other, are forty feet high and support the roof of the main passages and of the side-sections. Light and ventilation are furnished by large glass windows between the columns.

The interior arrangement has special regard to the shafting, which is admirably distributed over the building, so that all the machines can be readily driven by the main and supplemental shafts.

The extension for hydraulic machines is provided with a reservoir 60 feet wide, 160 feet long, and 10 feet deep, it being made with a view to exhibit the motors in full activity. South of the reservoir will be a waterfall of 35 feet height and 40 feet width, that is also to be supplied from the reservoir.

THE ART GALLERY.

[See page 25.]

THE most imposing and ornate of all the structures designed for the Exhibition is Memorial Hall, built, at a cost of $1,500,000, by the State of Pennsylvania and city of Philadelphia. This is placed at the disposal of the Centennial Commission, to be used during the Exhibition as an Art Gallery, after which it is designed to make it the receptacle of an industrial and art collection similar to the famous South-Kensington Museum, at London. It stands on a line parallel with, and a short distance northward of, the Main Building, and is in a commanding position, looking southward across the Schuylkill over Philadelphia. It stands upon a terrace 122 feet above the level of the Schuylkill. Being designed for an absolutely fire-proof structure, nothing combustible has been used. The design is modern Renaissance. It covers an acre and a half, and is 365 ft. long, 210 ft. wide, and 59 ft. high, over a spacious basement 12 ft. high. A dome, rising 150 ft. above the ground, surmounts the centre, capped by a colossal ball, from which rises the figure of Columbia. The main front of this building looks southward, displaying a main entrance in the centre consisting of three enormous arched doorways, a pavilion on each end, and two arcades connecting the pavilions with the centre. The entrance is 70 ft. wide, to which there is a rise of 13 steps. Each of the huge doorways is 40 ft. high and 15 ft. wide, opening into a hall. Between the arches of the doorways are clusters of columns terminating in emblematic designs illustrative of science and art. The doors are of iron, relieved by bronze panels, displaying the coats of arms of all the States and Territories. The United States coat of arms is in the centre of the main frieze. The dome is of glass and iron, of unique design. While Columbia rises at the top, a colossal figure stands at each corner of the base of the dome, typifying the four quarters of the globe. In each pavilion there is a large window 12½ ft. by 34 ft. There are altogether eight of these windows, which will be used for the display of stained glass, glass paintings, etc. Two of them have already been applied for from Munich, and application for space in them has also been made from England.

The arcades designed to screen the long walls of the galleries each consist of five groined arches, and form promenades looking outward over the grounds and inward over open gardens extending back to the main wall of the building. These garden-plots are each 90 ft. by 36 ft., ornamented in the centre with fountains, and intended to display statuary. The arcades are highly ornamented, and the balustrades of them and of the approaching stairways are also designed for statuary. The walls of the east and west sides of the structure display the pavilions and the walls of the picture-galleries, and are relieved by niches designed for statues. The frieze is richly ornamented, and above it the central dome shows to great advantage. The rear or north front of the building is of the same general character as the main front, but, in place of the arcade, has a series of arched windows, twelve in number, with the entrance in the centre. Between the pavilions is the grand balcony, a promenade 275 ft. long and 45 ft. wide, elevated 40 ft. above the ground, and overlooking to the northward the beautiful grounds of the Park. On each front of the buildings the entrances open into halls, 82 ft. long, 60 ft. wide, and 53 ft. high, decorated in modern Renaissance. These, in turn, open into the centre hall, 83 ft. square, the ceiling rising over it 80 ft. in height. From the east and west sides of this centre hall extend the galleries, each 98 ft. long, 48 ft. wide, and 35 ft. high. These galleries admit of temporary divisions for the better display of paintings, and with the centre hall form a grand hall 287 ft. long and 83 ft. wide, capable of comfortably accommodating 8000 persons. This is nearly twice the dimensions of the largest hall in the United States. From the galleries doorways open into two smaller galleries, 89 ft. long and 28 ft. wide. These open north and south into private apartments connecting with the pavilion-rooms, and forming two side-galleries 210 ft. long. Along the whole length of the north side of the main galleries and central hall extends a corridor 14 ft. wide, opening on its north line into a series of private rooms, twenty-three in number, designed for studios and smaller exhibition-rooms. All the galleries and the central hall are lighted from above ; the pavilions and studios from the sides. The pavilions and central hall are designed especially for the exhibition of sculpture. This fine building gives 75,000 square feet of wall space for paintings, and 20,000 square feet of floor space for statues, etc. The skylights throughout are double, the upper being of clear glass and the under of ground glass.

Liberal as are the accommodations thus provided for the display of art, they are altogether inadequate to the needs of the Exhibition. Austria alone has applied for an amount of space greater than the hall contains, and other European States are making preparations for the exhibition of their art treasures vastly in excess of what was anticipated. Already a supplementary building, to be connected with the north front of Memorial Hall by a covered way, has been decided upon. It will correspond in style with the main hall, and virtually form a part of it. It will be built of brick, and cover an area of over 50,000 square feet—380 ft. by 180 ft.—its interior to be divided into twenty-six galleries, two of 100 ft. by 40 ft., and the others 40 ft. square.

LESSONS IN MECHANICAL DRAWING.

THE series of excellent instructions begun in No. 1 of the SUPPLEMENT will be continued in our next. We hope that beginners will faithfully and abundantly practice the elementary directions last given. We have in store for them a large and excellent variety of examples for future efforts.

THEORIES OF THE TIDES.

AT the opening session of the Philosophical Society of Glasgow, November, Sir W. Thomson, LL.D., the president, gave an "account of La Place's and Airy's Dynamical Theories of the Tides." La Place, he pointed out, had found that all his predecessors, from the time of Newton, had chiefly confined themselves to the investigation of what the height of the water would be if all the forces concerned had time, so to speak, to produce effect, and he gave us the ocean under their influence. Newton's theory was that the deviations from the equilibrium notion were to be explained by the oscillations of water on account of the reciprocal motion on the sides of the Atlantic. The rotation of the earth is to be taken into account in a true dynamical theory of the tides, and this point did not seem to have occurred to Newton at all. Airy, who estimated this part of La Place's theory very highly, took up the subject of tides where the boundaries were precipitous cliffs, and worked out in detail the theory of tides in canals so as to throw great light on the whole subject. Having explained La Place's theory of axial tides, by means of which the motion of the tides arising from the declination of the sun and moon are calculated, the president showed, in conclusion, that in certain parts of the British seas a state of tide could be made out having some resemblance to the motion of sand on a vibrating plate, there being lines along which the water was heaped up while there were others of comparative rest.

INTERNATIONAL ROWING REGATTA.

CIRCULAR ISSUED BY REGATTA COMMISSION.

AMONG the athletic sports that will be held during the International Exhibition will be a series of boat-races on the Schuylkill River, a broad, beautiful stream, generally acknowledged among rowing men as one of the finest rowing courses in America, having high banks on each side, and in full view of the Exhibition Buildings.

The races, while under control of the United States Centennial Commission, will be under the management of the Schuylkill Navy, a boating organization composed of nine clubs, whose boat-houses are on the east bank of the river within Fairmount Park. The leading boating organizations of the country have consented to co-operate.

The Schuylkill Navy has been in existence since 1858, and has given a number of open regattas ; and from its past record and the experience of its members in conducting races, we have abundant guarantee that this series of regattas in 1876 will be most successful.

The Schuylkill Navy, besides furnishing quarters for the boats of visiting crews in their own boat-houses, purpose erecting temporary boat-houses in the Park, and will thus be enabled to accommodate all who may accept this invitation to take part in the races.

Arrangements have been made to hold the following races :

First. An International Race will be held, open to all regularly organized boat-clubs throughout the world, to be rowed in accordance with the rules of the National Amateur Rowing Association of the United States ; the prizes to be a piece of plate each for fours, for pairs, for doubles, and for single sculls, and, in addition, medals to be presented to each man rowing in the race, to be of gold for the winning crew, for the second crew of silver, and the remainder of bronze.

Second. An International College Race for four-oared shells will be held, the prize to be a piece of plate, with a gold medal to each member of the winning crew ; open only to undergraduates.

Third. An International Graduates' Race will be held for four-oared shells, open only to graduates of Colleges or Universities ; the prize being a piece of plate, and a gold medal to each member of the winning crew.

No person will be allowed to row in both the International College Race and International Graduates' Race.

Fourth. Professional Races will be held, open to all crews

throughout the world, for four-oared and single-scull shells for suitable purses, the amounts of which will be announced by the 1st of May, 1876.

The races will be held between the 20th of August and the 15th of September, and the entries shall be closed on July 15th.

An entrance fee of $25 will be charged for fours; $15 for pairs and doubles, and $10 for singles. This fee will be returned to all boats starting in the races, and is demanded as a guarantee of good faith in making the entry, and to justify the committee in making the necessary arrangements for properly housing the boats of the entering crews.

The Amateur Races will be rowed in heats one and a half miles straight away. The professional races will be rowed three miles, one and a half miles and return.

Besides the above prizes, the "Jury of Award on Rowing" of the United States Centennial Commission, who will have an oversight of all the races, will award the Diploma and Medal of the Commission to the victors.

The National Amateur Rowing Association will hold their annual regatta over the same course (the National) either previous to or immediately after the above International Races.

The following definition of an amateur oarsman with the required pledge will be strictly enforced for all entries in the regatta:

"The President or presiding officer and Secretary of each club entering either of the amateur races of regatta controlled by the Schuylkill Navy, will be required to certify on honor, in writing, that each member of the crew entered is strictly an amateur and is not paid, directly or indirectly, for his services, either by place, emolument, or office, as a member, or by reason of his being a member, of the club; that he 'does not enter in open competition for either a stake, public or admission money, or entrance fee, or compete with or against a professional for any prize, and has never taught, pursued, or assisted in the pursuit of athletic exercises as a means of livelihood, or has been employed in or about boats or in manual labor on the water.'"

EXTRACTS FROM THE LAWS OF BOAT-RACING.

1. All boat-races shall be started in the following manner: The starter, on being satisfied that the competitors are ready, shall give the signal to start.

2. If the starter considers the start false, he shall at once recall the boats to their stations, and any boat refusing to start again shall be disqualified.

3. Any boat not at its post at the time specified shall be liable to be disqualified by the umpire.

5. Each boat shall keep its own water throughout the race, and any boat departing from its own water will do so at its peril.

6. A boat's own water is its straight course, parallel with those of the other competing boats, from the station assigned to it at the starting to the finish.

7. The umpire shall be sole judge of a boat's own water and proper course during the race.

8. No fouling whatever shall be allowed; the boat committing a foul shall be disqualified.

9. It shall be considered a foul when, after the race has commenced, any competitor, by his oar, boat, or person, comes into contact with the oar, boat, or person of another competitor, unless in the opinion of the umpire such contact is so slight as not to influence the race.

11. The umpire, when appealed to, shall decide all questions as to a foul.

12. A claim of foul must be made to the judge or the umpire by the competitor himself before getting out of his boat.

13. In case of a foul the umpire shall have the power—

A. To place the boats, except the boat committing the foul, which is disqualified, in the order in which they came in.

B. To order the boats engaged in the race, other than the boat committing the foul, to row over again on the same or another day.

C. To restart the qualified boats from the place where the foul was committed.

14. Every boat shall abide by its accidents.

15. No boats shall be allowed to accompany a competitor for the purpose of directing his course or affording him any other assistance. The boat receiving such direction or assistance shall be disqualified at the discretion of the umpire.

18. Boats shall be started by their sterns, and shall have completed their course when the bows reach the "finish."

19. In turning-races each competitor shall have a separate turning-stake, and shall turn from port to starboard. Any competitor may turn any stake other than his own, but does so at his peril.

[From the Academy.]

ELECTRICITY.

Action of Light on the Electric Conductivity of Selenium.—An abstract of Professor W. G. Adams's paper on this subject is published in the *Proceedings* of the Royal Society (No. 163). Several series of experiments were made with the view—(1) To determine whether the change in the electrical resistance of selenium is due to the radiant heat, light, or chemical action; (2) To measure the amount of the change of resistance due to exposure to light of different sources transmitted through various absorbing media; and (3) To determine whether the action is instantaneous or gradual, and to measure the rate at which the action takes place. The average resistance of the selenium used was 2¼ megohms, and the battery used in most of the experiments consisted of 30 Leclanché cells. The absorbing media employed were bichromate of potash, sulphate of copper, ruby, orange, green, and blue glasses, also plates of rock-salt, alum, mica, and quartz. The general action of light upon selenium is to diminish its electrical resistance, and Professor Adams found by experiments with the electric light and rock-salt, alum, quartz, and a solution of iodine in bisulphide of carbon, that the resistance diminishes at the same rate as the illumination increases, and, moreover, that the obscure heat-rays have a very slight action. On the whole, Professor Adams's experiments prove that the action on the selenium is due principally, if not entirely, to radiations belonging to the visible portion of the spectrum. Light rays of all kinds, particularly the greenish-yellow, produce an instantaneous effect, followed by a more or less gradual effect, which continues to increase during exposure for several minutes. Two hypotheses are suggested as possible explanations:—(1) That the light falling on the selenium causes an electro-motive force in it, which opposes a battery-current passing through it, the effect being similar to the effect due to polarization in an electrolyte; (2) That the light falling on the selenium causes a change in its surface akin to the change which it produces on the surface of a phosphorescent body, and that in consequence of this change the electric current is enabled to pass more readily over the surface of the selenium.

A New Relation between Electricity and Light.—Faraday, who was acquainted with the method of studying the strains produced in transparent solids by means of polarized light, made many experiments in the hope of detecting some action on polarized light while passing through a medium in which dielectric induction exists. He was not, however, able to detect any action of this kind. Though his experiments were arranged in the way best adapted to discover effects of tension, he was unable to recognize any action on light due to static electric induction. Dr. Kerr, in a paper published in the November number of the *Philosophical Magazine*, describes experiments which he has recently made, which show that electrification of a non-conductor when sufficiently powerful is accompanied by optical effect. A piece of polished plate-glass is selected, three quarters of an inch thick, six inches long, and two wide. Two holes are drilled into the block from its opposite ends, and approach within a quarter of an inch of each other; in these are inserted thick copper wires, sheathed—except at their extremities—in gutta-percha. The electrification is effected by means of a powerful Ruhmkorff's induction apparatus, the outer ends of the wires from the glass plate being screwed into the knobs of the secondary coil. When the plate of glass is intensely electrified and traversed by polarized light in a direction perpendicular to the lines of force, Dr. Kerr found that a depolarizing action is exerted upon the light, giving an effect which is much more than merely sensible in a common polariscope. Electric force and optical effect increase together. The optical effect of a constant electric action takes a certain time to reach its full intensity, which it does by continuous increase from zero, and it falls again slowly to zero after the electric force has vanished. It was found further that the dielectrification of plate-glass is equivalent optically to a compression of the glass along the lines of electric force. Dielectrified glass acts upon transmitted light as a negative uniaxal crystal, with its axis parallel to the lines of force. Quartz (like glass) acts upon transmitted light as if compressed along the lines of force, while resin (unlike glass) acts as if extended along the lines of force. Dr. Kerr intends to examine the action of liquid dielectrics in the same way.

Development of Dynamic by means of Static Electricity.—The induction coil of Ruhmkorff affords the means of converting dynamic into static electricity. Professor Bichat (*Annales de Chim. et de Phys.*, sér. 5, tom. 6, p. 391) has sought to effect the inverse transformation. In the ordinary mode of using a Ruhmkorff's coil, a current successively made and broken is passed through the thick wire, the result being the production of two currents in opposite directions in the thin wire, equal in quantity but very unequal in tension. If the terminals of the thin wire be separated by a layer of air of sufficient thickness, the *direct* current alone passes. Conversely, it would seem that the machine of Ruhmkorff ought to be the most suitable apparatus for transforming static into dynamic electricity, and experiment fully confirms this prevision. If a series of sparks produced by a Holtz machine be passed through the fine wire of the bobbin, there are developed in the thick wire induced currents, which are distinguished from other induced currents produced by statical electricity by the facility with which they decompose water and saline solutions, and by the energy with which they deflect a galvanometer needle. In a voltameter with acidulated water we should expect to find equal volumes of detonating mixture produced at each of the electrodes, since the induced currents are equal in quantity and in opposite directions. On the contrary, however, we find that oxygen is disengaged on one side and hydrogen on the other, the gases forming water being thus separated from each other and almost pure. It would thus seem that there is a *single* current passing through the voltameter, which contradicts the known facts of induction. To explain this apparent contradiction the author availed himself of the phenomenon of the polarization of the electrodes, a method previously adopted by Verdet with success in his experiments on static induction. The method consists simply in this—that the voltameter, after its electrodes have become polarized by the passage through it for a short time of the induced current, is disconnected from the coil and put into communication with an insulated galvanometer, the change of connections being effected by means of a commutator. The direction and amount of the deflection of the galvanometer indicate the direction and strength of the induced current passing through the thick wire of the Ruhmkorff. The result showed that the current is *inverse*, namely, in contrary direction to the principal current furnished by the Holtz. These apparent anomalies are due to the difference in tension of the *two* currents which in reality are produced whether in the thick or thin wire. The explanation is simple: the balls of the discharger, included in the principal circuit, are charged slowly, owing to the great resistance of the fine primary wire, and discharged abruptly. The tension of the direct current, which corresponds to the rupture, is enormous in comparison with that of the inverse current, which proceeds from the slow establishment of the spark constituting the inducing current. The inverse current, which is produced first, arrives at the voltameter and decomposes the water. This decomposition results in the deposition on the platinum wires of a large quantity of microscopic gas-bubbles, which are not disengaged, and which hence are eminently adapted to the production of polarization-currents. The direct current which then arrives also decomposes the water, but, as it exists only during a very short time, it follows that the decomposition takes place rapidly. The bubbles of gas are larger, less adherent, and are disengaged at once, and are thus unable to effect more than a feeble polarization, quite incapable of destroying that due to the inverse current. Thus the apparent production of a single inverse current is owing to the difference in tension of the two induced currents.

NEW FORM OF MAGNET.

IF we allow a feeble current to pass through the wire of an ordinary electro-magnet, the latter immediately becomes magnetical; but superficially so, since the thickness of the magnetic layer is but a fraction of a millimetre.

In order to augment this thickness, we are obliged to increase the current more and more, until the magnetism reaches the centre.

But then, observing in what way the magnetism is distributed in the section of the electro-magnet, we find that it decreases from the circumference to the centre, being deficient even at the axis, and, if it is desirable to increase the total magnetism, it will be necessary to still increase the current until a certain limit is attained which it is impossible to exceed, and after which the electro-magnet, becoming heated, does not increase the magnetism.

Even when we have reached this limit, in electro-magnets of considerable diameter we still observe that the magnetism decreases from the circumference to the centre.

Theoretical considerations led me to think that, if it were possible to pass an isolated current, not only around the external layer of the iron cylinder of an ordinary magnet, but also around all the internal layers, we would obtain an electro-magnet susceptible of taking its limit of magnetism under the action of a very feeble current, and the power of which corresponding to this limit would be greater than in ordinary cases, since its magnetism would be equal in all points of its section, and, moreover, its atoms being at the least possible distance from the magnetizing current, its complete magnetism would be almost instantaneous, since the length of time would then only depend upon the variable period for the propagation of the current through the conductor which surrounds the electro-magnet.

Though it is impossible to realize this disposition in practice, we can, however, come very near it; and for that it suffices to construct an electro-magnet in the following manner: Each core is constituted by a series of concentric iron tubes (Fig. 1), 1, 2, 3, 4; 1′, 2′, 3′, 4′, leaving an interval between each equal to their thickness; on each of these tubes is coiled, always in the same direction, an isolated copper wire *b*, the thickness of the wire layer being greater on the external tube. The extremities *f* of the wire corresponding to each tube cross the breech of the magnet, and are united in such a way as to form a single conductor.

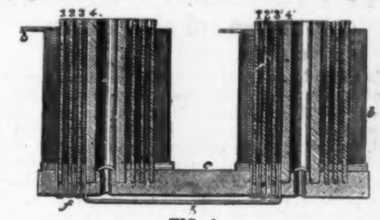


FIG. 1.

By employing the current of the ten Bunsen elements, of ordinary dimensions, the attractive force of an electro-magnet like the one above described (bobbin fifteen centimetres in diameter and seventeen centimetres in length), at a distance of one millimetre, is of one thousand kilogrammes, and at six millimetres of two hundred and fifty kilogrammes.

With an ordinary telegraphic electro-magnet of fifty kilometres of resistance, compared to another like one, but of the system above described, the result, in contact, was the following:

Ordinary electro-magnet, 4 kilogrammes } Leclanché 8
Tubular " " 20 " } elements

I should finally state that it was demonstrated by experiment that, if we cover the polar extremities of the tubes which constitute each core of these electro-magnets, by means of a round iron shield, the electro-magnet loses its great power, and is in the same conditions of an ordinary electro-magnet.—*M. A. Camacho (Journal de Physique).*

INCRUSTATION ON AN OLD FLUE.

By J. W. CHALMERS HARVEY.

ON opening an underground flue, 5 feet high and 3½ wide, by which the fires from a range of large boilers communicated with a high chimney, an incrustation was found on the roof and walls, covering an extent of upwards of 50 feet, and varying in thickness from ½ of an inch to nearly 1 inch in some places, the thickest parts forming a ridge exactly over the joinings of the bricks where the mortar had been exposed to the action of the gases. In fact, every joint stood out in such a way as to mark distinctly the form of each brick that had been used in lining the flue. The flue had been in constant use for about five years, and the boilers were fired with the Cumberland coal of the neighborhood, which is a caking coal, and contains on an average about 2 per cent of sulphur. The following is an analysis of the substance dried at 212° F.:

	Per Cent
Insoluble matter	23.39
Ferric oxide	2.91
Alumina	6.10
Lime	11.31
Magnesia	0.55
Sulphuric anhydride	38.14
Potash	6.47
Soda	0.52
Water	11.40
	100.79

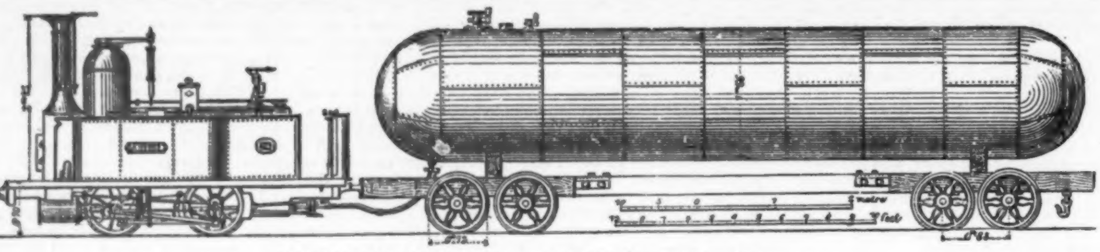
It appears from the above analysis that a very considerable proportion, if not the whole, of the sulphur dioxide first formed from the sulphur in the coal has been further oxidized into sulphuric acid before it reached the chimney, and acting upon the bases of which the lining of the flue is composed, converted them into sulphates. It seems also clear that the potash has been volatilized from the coal, as it is highly improbable that it owes its origin to the materials used in the construction of the flue.

In densely-populated manufacturing towns, if mortar was freely used in covering the interior of flues, or lime placed in some convenient part of them where it could be replenished from time to time, might it not be attended with beneficial sanitary results? as it would retain much of the sulphur dioxide that would otherwise escape into the atmosphere.—*Chemical News.*

THE ROYAL SOCIETY.

THE award of the medals in the gift of the society for the year 1875, by the council, is as follows:

The Copley medal to Professor A. W. Hofmann, F.R.S., for his numerous contributions to the science of chemistry, and especially for his researches on the derivatives of ammonia; a Royal medal to Mr. William Crookes, F.R.S., for his various chemical and physical researches, more especially for his discovery of thallium, his investigation of its compounds and determination of its atomic weight, and for his discovery of the repulsion referable to radiation; a Royal medal to Dr. Thomas Oldham, F.R.S., for his long and important services in the science of geology, first as Professor of Geology, Trinity College, Dublin, and Director of the Geological Survey of Ireland, and chiefly for the great work which he has long conducted as Superintendent of the Geological Survey of India, in which so much progress has been made that in a few years it will be possible to produce a geological map of India comparable to the geological map of England, executed by the late Mr. Greenough; also for the series of volumes of Geological Reports and Memoirs, including the "Palæontologia Indica," published under his direction. It is hoped that Dr. Hofmann may be spared from Berlin for a few days, so as to receive the medal in person. The medals will be presented at the anniversary meeting.



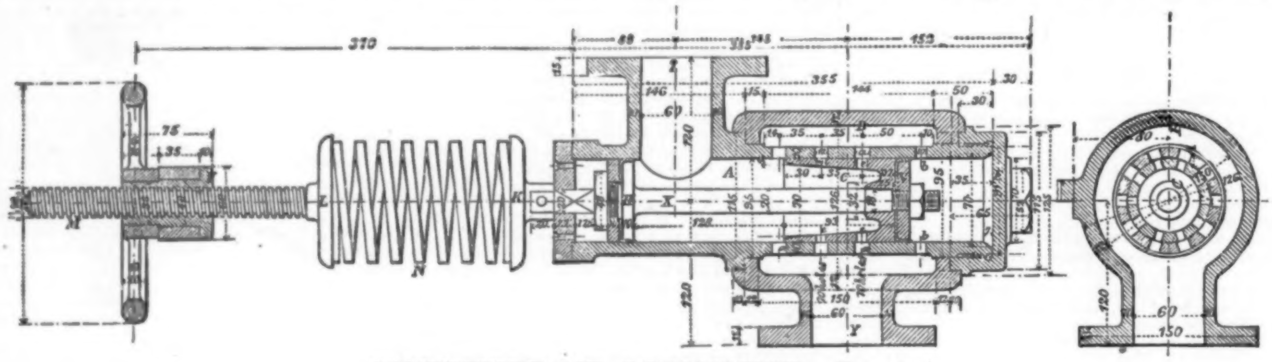
COMPRESSED-AIR LOCOMOTIVE.—Fig. 2.

COMPRESSED-AIR LOCOMOTIVE.

[Concluded from page 16.]

As before mentioned, it is advisable to admit the air into the cylinders at a low pressure, and to make the expansion as complete as possible. When this pressure is once regulated by the automatic reducing-valve, it can be increased or diminished, according to the gradient of the road, the weight to be hauled, or to other requirements of the traffic, by simply adjusting the screw which regulates the spring of the valve.

This apparatus is composed of a cylinder A A, Figs. 3 and 4, the interior of which is placed in connection, by means of a pipe Z, with the main reservoir, in which the pressure may be either constant or variable. For a portion of its length the cylinder A A is inclosed in a casing B B. The annular space between the cylinder and the casing is filled with the expanded air, which can escape by the pipe Y. The



COMPRESSED-AIR LOCOMOTIVE.—Fig. 3.

sides of the cylinder in the portions within the casing B B are pierced with two series of holes, *a a* and *b b*. The end of the cylinder towards which the latter are placed is closed with a cover, the other end being open to the atmosphere.

Within the cylinder A is a movable apparatus composed of a cylinder C, fitting easily, and in one piece with a rod X, on which are fixed two pistons, V and H. The cylinder C is pierced with a series of holes *e*, which, according to the position of the movable system, coincides either with the holes *a a*, or with the spaces left between these holes, in which case all escape of the air is prevented. During the movement of this part of the apparatus, the piston V is always between the series of holes *a* and *b*. It follows that the space between the bottom of the cylinder and the piston V is always in communication with the annular space B containing the expanded air. The two pistons V and H being of the same diameter, the moving portion remains always in a condition of equilibrium.

The end of the rod X carries a plate K, and opposite to it is another plate L, carried by a screwed spindle M, which is maintained at a constant distance from the cylinder A. A spring N is interposed between the two plates, and tends always to keep them separated. The plate L being fixed in relation to the cylinder A, the spring N tends to force the movable portion towards the bottom of the cylinder, and so to keep the holes *e* of the movable cylinder opposite the holes *a* of the fixed one. If compressed air be admitted into Z, it flows through the openings *e* and *a*, and expands into the annular space B. In passing through the holes *b*, it produces, by reason of its pressure, a motion of the piston V, opposed to the spring N. When this effort becomes greater than that exerted by the spring, the movable portion of the apparatus advances towards the open end of the cylinder, and the holes *a* are closed.

When there is a continued flow of compressed air through Y the movable cylinder C takes intermediate positions, the holes *e* partially coinciding with the holes *a*, so as to uncover more or less of their area, the dimensions of these openings depending directly upon the pressure of the air, increasing if this diminishes, and *vice versa*. The pressure to which these results are due depends only on the tension of the spring, no matter what the initial pressure of the air may be at Z. If therefore air be admitted, under either a constant or a variable pressure, it will flow from Y, at a constant pressure, always inferior, of course, to the initial pressure.

When the pressure in Y is once determined by means of the spring N, it may be regulated at will within certain limits by means of the screw M, by which the tension of the spring may be increased or diminished.

It will be seen from the above description that, by means of this apparatus applied to the compressed-air engine, the expansion of the air is effected by means of variable openings, the area of which is fixed by the pressure acting on the piston forming part of the apparatus, and balanced by a spring, the tension of which fixes the amount of this pressure. By adjusting the spring by means of a hand-wheel and screw, a range of pressures can be commanded with the same apparatus.

The leading particulars of the engine we have described are as follows:

Capacity of the principal reservoir	268 cubic feet.
" " small "	10.6 " "
Maximum pressure in large "	105 lbs.
Mean " small "	60 lbs.
Length of stroke	14.17 in.
Diameter of cylinders	8 in.
" wheels	29¼ in.
Weight of engine	about 6 tons 15 cwt.
Width of gauge	39.37 in.

All the principal dimensions are shown upon the drawings.

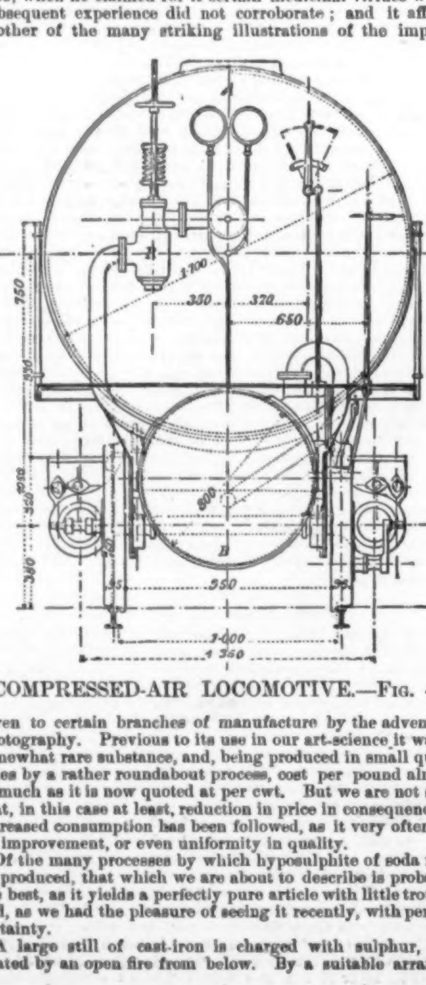
[British Journal of Photography.]

HYPOSULPHITE OF SODA.

There is probably no substance used in photography against which so many charges of "misconduct" have been brought as that which heads this article; and, while we are willing to admit that many of these charges should more properly be brought against the faulty manipulation of those who use it, there can be little doubt that in too many cases it has been the source of many failures. Notwithstanding this, however, it still maintains its ground as one of the most useful and generally-used substances in the photographic laboratory. This position it holds in consequence of the fact that it is one of the most convenient solvents of certain salts of silver, or, to put it more correctly, because it readily combines with certain salts of silver to form hyposulphite of silver, which is soluble in excess of the alkaline hyposulphite, and that the soluble salt thus formed is more or less easily and perfectly removed from the insoluble image which has been formed in or on the film or supporting body.

Our attention has been directed to this subject in consequence of several communications we have received—some having appeared in our columns—in which doubts were raised as to the quality of the article with which our correspondents had been supplied; so we resolved to examine into the matter a little more fully than we had hitherto done, and, by experiments on a number of samples collected from various sources, ascertain how far uniformity of product had been attained by the various manufacturers of the substance.

Hyposulphite of soda was first noticed by Chaussier in 1799, when he claimed for it certain medicinal virtues which subsequent experience did not corroborate; and it affords another of the many striking illustrations of the impetus



COMPRESSED-AIR LOCOMOTIVE.—Fig. 4.

given to certain branches of manufacture by the advent of photography. Previous to its use in our art-science it was a somewhat rare substance, and, being produced in small quantities by a rather roundabout process, cost per pound almost as much as it is now quoted at per cwt. But we are not sure that, in this case at least, reduction in price in consequence of increased consumption has been followed, as it very often is, by improvement, or even uniformity in quality.

Of the many processes by which hyposulphite of soda may be produced, that which we are about to describe is probably the best, as it yields a perfectly pure article with little trouble and, as we had the pleasure of seeing it recently, with perfect certainty.

A large still of cast-iron is charged with sulphur, and heated by an open fire from below. By a suitable arrangement a stream of sulphuric acid is allowed to flow into the still and come into contact with the melted sulphur. In this way two molecules of sulphuric acid give up each an atom of oxygen, which, uniting with one atom of sulphur, form three molecules of sulphurous acid, thus: $2\,SO_3 + S = 3\,SO_2$. The sulphurous acid is led, by a suitable prolongation of the still-head, into a digester or large vessel, which is filled with crystals of carbonate of soda. The digester has a perforated false bottom on which the crystals are packed, and the gas is forced in between this and the bottom proper. In this way it is brought into contact equally with the whole body of crystals, and, after the action has continued some forty-eight hours, the whole mass is found to be converted into the acid sulphite of soda, with liberation of carbonic anhydride. This acid sulphite ($Na\,H\,S\,O_3$) is then dissolved in water and converted into the neutral sulphite ($Na_2\,S\,O_3$) by the addition of as much carbonate of soda as was previously used. To the boiling solution of neutral sulphite a quantity of sulphur is lastly added, and after the heat has been kept up for some time each molecule of the salt combines with an atom of sulphur, and hyposulphite of soda is the result, thus: $Na_2\,S\,O_3 + S = Na_2\,S_2\,O_3$. When the combination between the neutral sulphite and the sulphur is complete the clear liquor is pumped or run into large wooden troughs, where the salt crystallizes in the form in which it is met with in commerce.

This we believe to be the best process of manufacture; but we were assured by the manufacturer at whose works we saw the operation carried on that from the price at which the article is frequently quoted—from twelve shillings to fifteen shillings per cwt.—it was not the one generally adopted. It is, therefore, much more likely that it is formed from some waste product; and as various manufacturers may use different materials, it is not improbable that, while the chemical constitution of the salt may be in all cases alike, the incidental and accidental impurities may vary materially. With a view to ascertain roughly how far this is the case, we recently procured a number of samples of ordinary commercial hyposulphite of soda, and made a large number of comparative experiments in relation to their solvent power on chloride of silver and the blue iodide of starch.

In the first place, the samples varied considerably in appearance. Some of them were in large transparent crystals and perfectly dry to the touch, while others were small and semi-opaque, and evidently somewhat deliquescent. Most of them had an alkaline reaction, one or two were quite neutral, and one was decidedly acid. A sample made as previously described, and which from previous experiments we knew to be of good quality, was taken as a standard, and made to act on chloride of silver and iodide of starch in the following manner: A solution of the hyposulphite was made (of such a strength that each cubic centimetre contained one grain) and placed in a suitable burette. Then five grains of nitrate of silver were dissolved in a test tube, and converted into chloride by chloride of sodium, and well washed. Into this the soluti n of hyposulphite was allowed to flow—freely at first, but drop by drop as the chloride dissolved; and when that was accomplished the quantity of liquid used was read off and noted. In the same way the iodide of starch from one grain of pure iodine was treated, and a mean of several experiments gave the following result: 5.8 grains of hyposulphite were required to dissolve the chloride formed from five grains of nitrate of silver, and .8 of a grain was required to decolor the iodide of starch from one grain of iodine. This, as we expected, was the highest result obtained, the other nine samples requiring from 8.7 to 6.6 for the nitrate of silver, and from 1.3 to .9 of a grain for the iodide of starch.

Now, although there is, doubtless, considerable latitude allowable in the strength of the solutions of hyposulphite used in photography, such a difference as that between 5.8 and 8.7 in the solvent power of the article must to a considerable extent interfere with any thing like exact, uniform work; and we may, in all fairness, throw out the hint that, although it is desirable to study economy in the purchase of even such an inexpensive article as hyposulphite of soda, it is possible that what may appear the cheapest at the beginning may rot prove to be so at the end.

With regard to the keeping qualities of hyposulphite of soda—about which a question has recently been raised—we may say that one of the best samples examined has, to our own knowledge, been in the cask from which we took it for at least seven years, and is apparently as good now as when made. Neither do we think it is liable to change when kept in solution. Hyposulphite, however, that has been once used for fixing prints should on no account be kept and used a second time. The hyposulphite of silver formed in the solution is an extremely unstable body, and begins almost immediately to decompose, the result being the formation, amongst

other substances, of sulphide of silver and sulphuric acid. We are aware that it is no uncommon practice with many photographers to keep a portion of used hyposulphite solution to add to that freshly made up, in the belief that thereby the prints suffer less lowering in intensity. The practice is, to say the least, of doubtful advantage—nay, is more than doubtful, so far as safety or security from failing is concerned.

We have said that some of the samples of hyposulphite of soda we examined gave neutral solutions, and that one was decidedly acid. Now, it is generally conceded that the purity of the whites of a print are best maintained when the fixing solution is decidedly alkaline. In order to secure this condition, we know that many are in the habit of adding to each batch of solution a few drops of ammonia or other suitable alkali; and we believe that if those who have not hitherto done this would give it a fair trial they would find, by so doing, their prints considerably improved.

ELLIPTICAL GEARING.

By Prof. C. W. MacCord, Stevens Institute.

THE fact that under certain conditions elliptical wheels will work together about fixed centres is well known; but thorough familiarity with their construction is not so common,

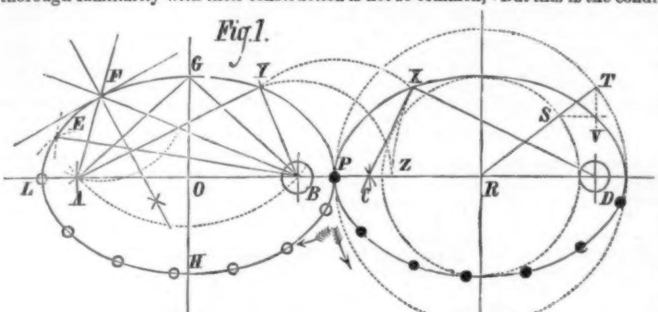


Fig. 1.

and indeed there seems to be, especially in regard to the forms of the teeth, very little on record in the way of instructions. By the aid of those given below, we believe that any careful draughtsman will be able to lay out these wheels and their teeth in such a manner as to satisfy all the requirements of practical mechanism. It is not pretended that the constructions are infinitesimally exact, but the deviations from

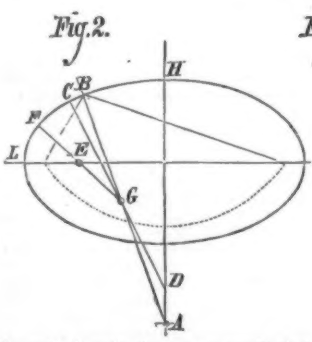


Fig. 2.

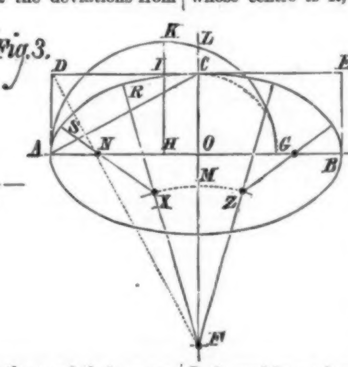


Fig. 3.

theoretical perfection are so small that they and their consequences may be disregarded, as not appreciably affecting the action.

Various methods of constructing ellipses approximately by means of circular arcs are to be found laid down in treatises on drawing, of which only one that we have met with is reasonably general and exact, and will be given in its proper

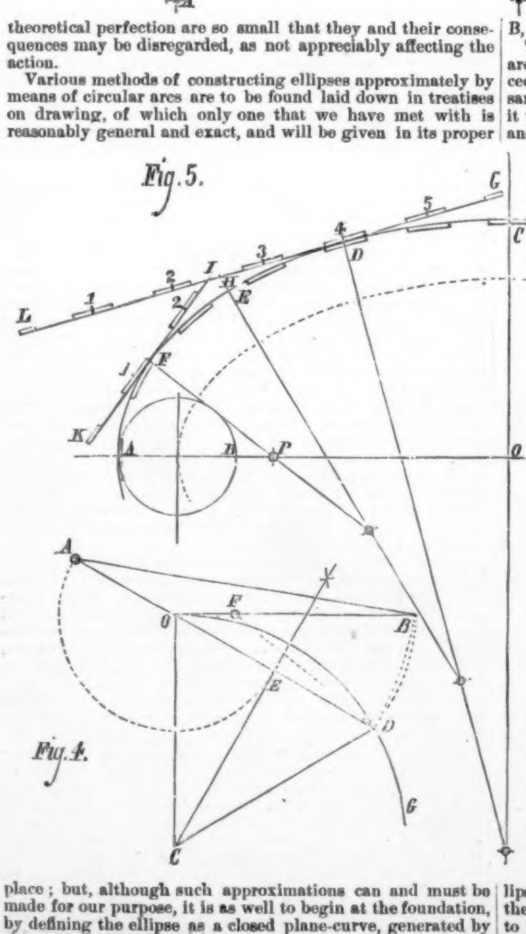


Fig. 5.

Fig. 4.

place; but, although such approximations can and must be made for our purpose, it is as well to begin at the foundation, by defining the ellipse as a closed plane-curve, generated by the motion of a point subject to the condition that the sum of its distances from two fixed points within shall be constant.

Thus, in Fig. 1, A and B are the two fixed points, called the *foci*; L, E, F, G, P are points in the curve; and A F + F B = A—E + E B. Also, A L + L B = A P + P B = A G + G B. From this it follows that A G = L O, O being the centre of the curve, and G the extremity of the minor axis, whence the foci may be found if the axes be assumed, or, if the foci and one axis be given, the other axis may be determined. It is also apparent that if about either focus, as B, we describe an arc with a radius greater than B P and less than B L, for instance B E, and about A another arc with radius A E = L P — B E, the intersection, E, of these arcs will be on the ellipse; and in this manner any desired number of points may be found, and the curve drawn by the aid of sweeps.

Having completed this ellipse, prolong its major axis, and draw a similar and equal one, with its foci, C, D, upon that prolongation, and tangent to the first one at P; then B D = L P. About B describe an arc with any radius, cutting the first ellipse at Y and the line L at Z; about D describe an arc with radius D Z, cutting the second ellipse in X; draw A Y, B Y, C X, and D X. Then A Y = D X, and B Y = C X, and because the ellipses are alike, the arcs P Y and P X are equal. If then B and D are taken as fixed centres, and the ellipses turn about them as shown by the arrows, X and Y will come together at Z on the line of centres; and the same is true of any points equally distant from P on the two curves. But this is the condition of rolling contact: We see, then, that in order that two ellipses may roll together, and serve as the pitch-lines of wheels, they must be equal and similar, the fixed centres must be at corresponding foci, and the distance between these centres must be equal to the major axis. Were they to be toothless wheels, it would evidently be essential that the outlines should be truly elliptical; but the changes of curvature in the ellipse are gradual, and circular arcs may be drawn so nearly coinciding with it, that when teeth are employed, the errors resulting from the substitution are quite inappreciable. Nevertheless, the rapidity of these changes varies so much in ellipses of different proportions, that we believe it to be practically better to draw the curve accurately first, and to find the radii of the approximating arcs by trial and error, than to trust to any definite rule for determining them; and for this reason we give a second and more convenient method of finding points, in connection with the ellipse whose centre is R, Fig. 1. About the centre describe two circles, as shown, whose diameters are the major and minor axes; draw any radius, as R T, cutting the first circle in T, and the second in S; through T draw a parallel to one axis, through S a parallel to the other, and the intersection, V, will lie on the curve in the left-hand ellipse, the line bisecting the angle A F B is normal to the curve at F, and the perpendicular to it is tangent at the same point, and bisects the angles adjacent to A F B, formed by prolonging A F, B F.

To find by trial and error the centres and radii of circular arcs, which may be used instead of the exact ellipse, we proceed as shown in Fig. 2. Prolonging the minor axis if necessary, we seek for a centre, A, such that the arc struck about it with radius A H shall coincide sensibly with the curve; and it is always possible to find such a radius that the circular arc will, for some distance on each side of H, agree so nearly with the ellipse that the eye can not detect the difference. At the point B where the divergence becomes perceptible, or rather a little nearer to H, draw a normal, which should pass through A; if the point first selected, as C, should be too far from H, the normal C D will cut A H at D, between A and H; if, on the other hand, it should be too near H, this intersection will fall below A: one or two trials will in general suffice to determine the point B, the normal through which will pass through the centre A, and the arc B H may then be used. Similarly the centre E on the major axis is found, about which the arc L F is struck, the normal through F passing through E. The prolongation of F E must contain the centre of the arc which is to be struck for continuing the curve in the direction F C, and the centre of the one which joins H B must lie on A B. Usually a sufficiently close approximation will be made by producing F E to cut A B in G, about which point the arc F B is struck; in order that F G may be equal to B G it may be necessary to change slightly the point F, and possibly the centre E, from the positions assigned at the first trial. Should the proportions of the ellipse be such that this approximation is unsatisfactory, the quadrant of the ellipse may, by extending this process, be made up of four arcs instead of three, as shown in Fig. 5.

In this manner, by the exercise of due care, very close approximations can be made; but we extract from Appleton's Cyclopædia of Drawing the following construction, which gives very good results for ellipses of many proportions, and is perhaps more readily executed. Let O, Fig. 3, be the centre of the proposed ellipse, A B the major axis, O C half the minor axis. Draw the rectangle A D E B; draw A C and D F perpendicular to it, cutting A B in N, and C O produced in F. Make O G = O C, bisect A G in H, about which point describe the semicircle on A G as diameter, cutting O C produced in L, and erect the radius H K perpendicular to A B, cutting D E in I. Set off O M = I K, and describe an arc about F with radius F M; then with centres A and B and radius equal to O L describe arcs cutting the one last mentioned in X and Z; then about F with radius F C describe the arc for the first part of the ellipse, cutting F X produced in R; with

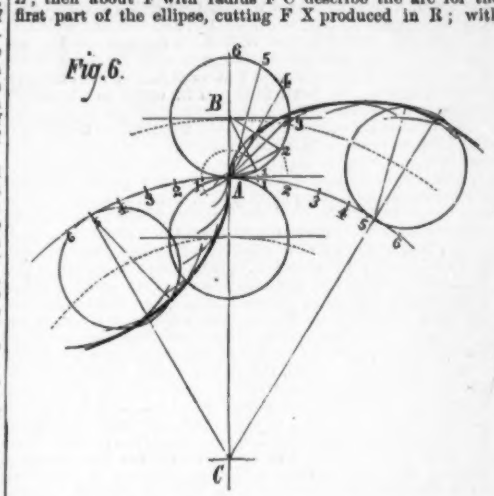


Fig. 6.

centre X and radius X R describe the next portion, R S, limited by the prolongation of X N; and complete the quadrant by describing the arc S A with centre N and radius N S.

If it were possible to subdivide the ellipse into equal parts it would be unnecessary to resort to these processes of approximately representing the true curve by arcs of circles; but unless this be done, the spacing of the teeth can only be, effected by the laborious process of stepping off the perimeter into such small subdivisions that the chords may be regarded

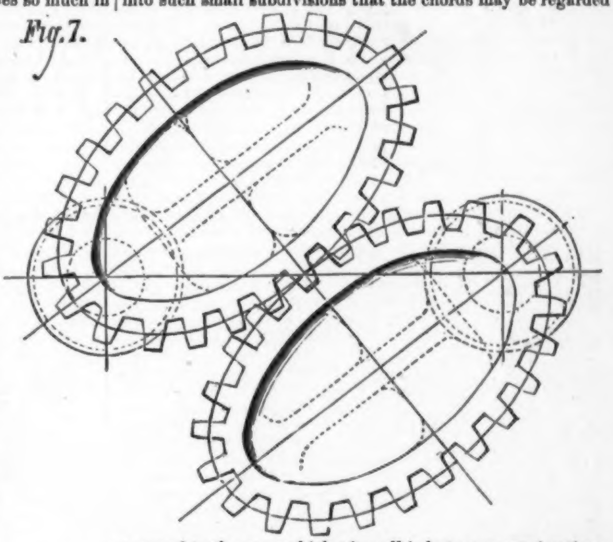


Fig. 7.

as equal to the arcs, which after all is but an approximation; unless, indeed, we adopt the mechanical expedient of cutting out the ellipse in metal or other substance, measuring and subdividing it with a strip of paper or a steel tape, and wrapping back the divided measure in order to find the points of division on the curve.

But these circular arcs may be rectified and subdivided with great facility and accuracy by a very simple process, which we take from Prof. Rankine's "Machinery and Mill Work," and is illustrated in Fig. 4. Let O B be tangent at O to the arc O D, of which C is the centre. Draw the chord D O, bisect it in E, and produce it to A, making O A = O E; with centre A and radius A D describe an arc cutting the tangent in B; then O B will be very nearly equal in length to the arc O D, which, however, should not exceed about 60°; if it be 60°, the error is theoretically about $\frac{1}{900}$ of the length of the arc, O B being so much too short; but this error varies with the fourth power of the angle subtended by the arc, so that for 30° it is reduced to $\frac{1}{16}$ of that amount, that is, to $\frac{1}{14400}$. Conversely, let O B be a tangent of given length; make O F = $\frac{1}{4}$ O B; then with centre F and radius F B describe an arc cutting the circle O D G (tangent to O B at O) in the point D; then O D will be approximately equal to O B,

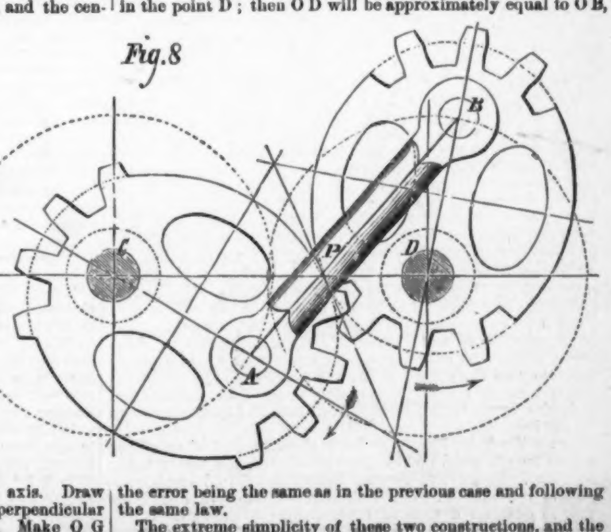


Fig. 8

the error being the same as in the previous case and following the same law.

The extreme simplicity of these two constructions, and the facility with which they can be made with the instruments always in the draughtsman's hands, make these exceedingly

convenient, and they should be more widely known than they are. Their application to the present problem is shown in Fig. 5, which represents a quadrant of an ellipse, the approximate arcs C D, D E, E F, F A having been determined by trial and error. In order to space this off, for the positions of the teeth, a tangent is drawn at D, upon which is constructed the rectification of D C, which is D G, and also that of D E in the opposite direction, that is, D H, by the process just explained. Then, drawing the tangent at F, we set off in the same manner F I = F E, and F K = F A, and then measuring H L = I K, we have finally G L, equal to the whole quadrant of the ellipse.

Let it now be required to lay out twenty-four teeth upon this ellipse; that is, six in each quadrant; and for symmetry's sake we will suppose that the centre of one tooth is to be at A, and that of another at C. We, therefore, divide L G into six equal parts at the points 1, 2, 3, etc., which will be the centres of the teeth upon the rectified ellipse. It is practically necessary to make the spaces a little greater than the teeth; but if the greatest attainable exactness in the operation of the wheels is aimed at, it is important to observe that backlash, in elliptical gearing, has an effect quite different from that resulting in the case of circular wheels. When the pitch-curves are circles, they are always in contact; and we may, if we choose, make the tooth only half the breadth of the space, so long as its outline is correct. When the motion of the driver is reversed, the follower will stand still until the backlash is taken up, when the motion will go on with a perfectly constant velocity ratio as before. But in the case of two elliptical wheels, if the follower stand still while the driver moves, which must happen when the motion is reversed if backlash exists, the pitch-curves are thrown out of contact, and, although the continuity of the motion will not be interrupted, the velocity ratio will be affected. If the motion is never to be reversed, the perfect law of the velocity ratio due to the elliptical pitch-curve may be preserved by reducing the thickness of the tooth, not equally on each side, as is done in circular wheels, but wholly on the side not in action. But if the machine must be capable of acting indifferently in both directions, the reduction must be made on both sides of the tooth: evidently the action will be slightly impaired, for which reason the backlash should be reduced to a minimum. Precisely what *is* the minimum it is not so easy to say, as it evidently depends much upon the excellence of the tools and the skill of the workman. In many treatises on constructive mechanism it is variously stated that the backlash should be from one fifteenth to one eleventh of the pitch: which would seem to be an ample allowance in reasonably good castings not intended to be finished, and quite excessive if the teeth are to be cut; nor is it very obvious that its amount should depend upon the pitch any more than upon the precession of the equinoxes. On paper, at any rate, we may reduce it to zero, and make the teeth and spaces equal in breadth, as shown in the figure, the teeth being indicated by the double lines. Those upon the portion L H are then laid off upon K I, after which these divisions are transferred to the ellipse by the second of Prof. Rankine's constructions, and we are then ready to draw the teeth.

The outlines of these, as of any other teeth upon pitch-curves which roll together in the same plane, depend upon the general law, that they must be such as can be marked out upon the planes of the curves as they roll by a tracing-point which is rigidly connected with and carried by a third line moving in rolling contact with both the pitch-curves. And since under that condition the motion of this third line, relatively to each of the others, is the same as though it rolled along each of them separately while they remained fixed, the process of constructing the generated curves becomes comparatively simple. For the describing line, we naturally select a circle, which, in order to fulfil the condition, must be small enough to roll within the pitch ellipse; its diameter is determined by the consideration, that if it be equal to A P, the radius of the arc A F, the flanks of the teeth in that region will be radial, which gives a form deficient in strength. We have therefore chosen a circle whose diameter, A B, is three fourths of A P, as shown, so that the teeth, even at the ends of the wheels, will be broader at the base than on the pitch line. This circle ought strictly to roll upon the true elliptical curve, and assuming as usual the tracing-point upon the circumference, the generated curves would vary slightly from true epicycloids, and no two of those used in the same quadrant of the ellipse would be exactly alike. Were it possible to divide the ellipse accurately, there would be no difficulty in laying out these curves; but having substituted the circular arcs, we must now roll the generating circle upon these as bases, thus forming true epicycloidal teeth, of which those lying upon the same approximating arc will be exactly alike. Should the junction of two of these arcs fall within the breadth of a tooth, as at D, evidently both the face and the flank on one side of that tooth will be different from those on the other side; should the junction coincide with the edge of a tooth, which is very nearly the case at F, then the face on that side will be the epicycloid belonging to one of the arcs, its flank a hypocycloid belonging to the other; and it is possible that either the face or the flank on one side should be generated by the rolling of the describing circle partly on one arc, partly on the one adjacent, which, upon a large scale and where the best results are aimed at, may make a sensible change in the form of the curve.

The convenience of the constructions given in Fig. 4 is nowhere more apparent than in the drawing of the epicycloids, when, as in the case in hand, the base and generating circles may be of incommensurable diameters; for which reason we have, in Fig. 6, shown its application in connection with the most rapid and accurate mode yet known of describing those curves. Let C be the centre of the base circle; B that of the rolling one; A, the point of contact. Divide the semicircumference of B into six equal parts at 1, 2, 3, etc; draw the common tangent at A, upon which rectify the arc A2 by process No. 1, then by process No. 2 set out an equal arc A2 on the base circle, and stepping it off three times to the right and left, bisect these spaces, thus making subdivisions on the base circle equal in length to those on the rolling one. Take in succession as radii the chords A1, A2, A3, etc., of the describing circle, and with centres 1, 2, 3, etc., on the base circle, strike arcs either externally or internally, as shown respectively on the right and left: the curve tangent to the external arcs is the epicycloid, that tangent to the internal ones the hypocycloid, forming the face and flank of a tooth for the base circle.

In the diagram, Fig. 5, we have shown a part of an ellipse whose length is ten inches and breadth six, the figure being half size. In order to give an idea of the actual appearance of the combination when complete, we show in Fig. 7 the pair in gear, on a scale of three inches to the foot. It will be remarked that the eccentricity is frightful, the distance between the foci being eight inches, so that if it were ever desired to use such a pair, which is very doubtful, the shafts would have to be attached by means of brackets at the back, as shown. This excessive eccentricity was selected merely for the purpose of illustration; and it may be remarked that the construction given in Fig. 3 was found decidedly inapplicable, the portion R S as thus described deviating very materially from the correct elliptical outline. Fig. 7 will serve also to call attention to another serious circumstance, which is that although the ellipses are alike, the wheels are not; nor can they be made so if there be an even number of teeth, for the obvious reason that a tooth upon one wheel must fit into a space on the other; and since in the first wheel, Fig. 5, we chose to place a tooth at the extremity of each axis, we must in the second one place there a space instead; because at one time the major axes must coincide, as in Fig. 1; at another, the minor axes, as in Fig. 7. If then we use even numbers, the distribution and even the forms of the teeth are not the same in the two wheels of a pair. But this complication may be avoided by using an odd number of teeth, since, placing a tooth at one extremity of the major axis, a space will come at the other, as indicated by the divisions on the lower halves of the ellipses in Fig. 1, the small circles indicating the centres of the teeth, which are the same in number and arrangement in both wheels.

It is not, however, always necessary to cut teeth all round these wheels, as will be seen by an examination of Fig. 8, C and D being the fixed centres of the two ellipses in contact at P. Now P must be on the line C D, whence, considering the free foci, we see that P B is equal to P C, and P A to P D; and the common tangent at P makes equal angles with C P and P A, as also with P B and P D; therefore, C D being a straight line, A B is also a straight line and equal to C D. If then the wheels be overhung, that is, fixed on the ends of the shafts outside the bearings, leaving the outer faces free, the moving foci may be connected by a rigid link, A B, as shown.

This link will then communicate the same motion that would result from the use of the complete elliptical wheels, and we may therefore dispense with the most of the teeth, retaining only those near the extremities of the major axes, which are necessary in order to assist and control the motion of the link at and near the dead-points. The arc of the pitch-curves through which the teeth must extend will vary with their eccentricity; but in many cases it would not be greater than that which in the approximation may be struck about one centre, so that in fact it would not be necessary to go through the process of rectifying and subdividing the quarter of the ellipse at all, as in this case it can make no possible difference whether the spacing adopted for the teeth to be cut would "come out even" or not if carried around the curve. By this expedient, then, we may save not only the trouble of drawing, but a great deal of labor in making, the teeth round the whole ellipse. We might even omit the intermediate portions of the pitch ellipses themselves; but as they move in rolling contact their retention can do no harm, and in one part of the movement will be beneficial, as they will do part of the work; for if, when turning as shown by the arrows, we consider the wheel whose axis is D as the driver, it will be noted that its radius of contact, C P, is on the increase; and so long as this is the case, the other wheel will be compelled to move by contact of the pitch lines, although the link be omitted. And even if teeth be cut all round the wheels, this link is a comparatively inexpensive and a useful addition to the combination, especially if the eccentricity be considerable. Of course the wheels shown in Fig. 8 might also have been made alike, by placing a tooth at one end of the major axis and a space at the other, as above suggested. In regard to the variation in the velocity ratio, it will be seen, by reference to Fig. 1, that if D be the axis of the driver, the follower will in the position there shown move faster, the ratio of the angular velocities being $\frac{PD}{PB}$; if the driver turn uniformly, the velocity of the follower will diminish, until, at the end of half a revolution, the velocity ratio will be $\frac{PB}{PD}$; in the other half of the revolution these changes will occur in a reverse order. But P D = L B: if then the centres B D are given in position, we know L P, the major axis; and in order to produce any assumed maximum or minimum velocity ratio, we have only to divide L P into segments whose ratio is equal to that assumed value, which will give the foci of the ellipse, whence the minor axis may be found and the curve described. For instance, in Fig. 7 the velocity ratio being nine to one at the maximum, the major axis is divided into two parts, of which one is nine times as long as the other; in Fig. 8, the ratio is as one to three, so that, the major axis being divided into four parts, the distance A C between the foci is equal to two of them, and the distance of either focus from the nearer extremity of the major axis equal to one, and from the more remote extremity equal to three, of these parts.

ACTION OF BORAX ON FERMENTATION AND PUTREFACTION.

M. DUMAS has established the fact that there are two classes of ferments. The first class live and are multiplied during fermentation, and have for type the *yeast of beer;* the second are destroyed during their action, and have for type *diastase.* Reserving the name of *fermentation* for the chemical action produced by ferments of the first type, M. Dumas arrives at this conclusion: that fermentation is a chemical phenomenon accomplished under the necessary influence of the life of the yeast. After having studied the action of a great number of substances on yeast, he studied the action of borax. This body coagulates yeast, dissolves the membranes that remain in suspension in a non-filtered solution of white of egg, prevents the inversion of sugar by *yeast*, arrests the action of *diastase*, and paralyzes *synaptase.*

The above observations were taken as point of departure for the following experiments:

I. *Action of borax on the protoplasm of vegetable cells.*

Leaves of the *Elodea Canadensis* (*water-weed*), the protoplasm in the cells of which presents a rotatory movement, were plunged into a concentrated solution of borax. The protoplasmic current continued for a few minutes, then grew slower, and finally stopped; the protoplasm contracted, withdrew from the walls of the cell, and condensed into one or two rounded masses, inclosing particles of chlorophyl. The living matter of the cell had been destroyed by the borax.

While observing the spores of *Vancheria clavata*, I noticed in the long tubular cells of some individuals, that had no spores, movements of the protoplasm in every direction. When, by slight pressure, the protoplasm was made to leave the cell, it still presented the same brisk molecular movement. On plunging fresh and entire *Vancheria* into a concentrated solution of borax, the protoplasm coagulates and withdraws from the cell-walls, the latter becoming perfectly hyaline. The globules of chlorophyl contract and assume a crescentic shape.

The spores of *Vancheria*, when out of the mother cell, execute rapid movements, which are immediately arrested by a solution of borax; the protoplasm is transformed into a fine granular mass.

Examining the influence of borax on the *Oidium Tuckeri*, that invaded the grape, it was found that the molecular movements of the spores were independent of the protoplasmic currents. These spores coagulated and became granular under the influence of borax.

II. *Action of borax on the animal organism.*

Animalcules placed in a drop of water to which is added a concentrated solution of borax, have their movements arrested and die, while the sarcode of the infusoria coagulates

The larva of frogs, rendered transparent by being kept in prolonged obscurity, present convulsive contraction of the muscular fibres of the tail when placed in a solution of borax, and the circulation so easy to observe in these animals is lessened little by little, and the plasma of the blood coagulates, killing the animal in less than an hour.

III. *Action of borax on fermentible matters.*

In October, 1872, I placed some berries and very ripe grapes into a concentrated solution of borax; the whole was introduced into a bottle, and well sealed. The liquid, at first colorless, became slightly brownish in color, but to-day (January, 1875) the berries and grapes present the same appearance that they did two years ago, there being not a trace of fermentation. I repeated the same experiment with gooseberries, with similar results. As long as the bottle remained well sealed there was no mouldiness; but on slight access of air, mould (mucor) was formed without fermentation. When, as counter-proof, we introduced berries and grapes in a well-sealed bottle filled with ordinary water, at the end of a certain length of time variable with the temperature there was fermentation with liberation of carbonic acid. In the same manner, fresh milk was preserved from fermentation for several months. Fresh milk preserved under like conditions, with the exception of the presence of borax, underwent fermentation in a few days, and became thick by the coagulation of the casein.

A pound of beef placed in a concentrated solution of borax in an hermetically-sealed tin box, gave off a disagreeable odor, which had nothing in common with that of putrefaction. After more than a year and a half, notwithstanding the heat of the summers of 1873 and 1874, this meat had not the least odor of putrefaction, and appeared like fresh meat. This same meat exposed to the air did not putrefy.

These same experiments repeated with other meats gave similar results. The *sui generis* odor possessed by meat which has been preserved for a certain length of time in a borax solution seems due to the decomposition of material resulting from the metamorphoses of substances composing the muscular fibre or intermuscular plasma.

A concentrated solution of borax might be utilized for the preservation of anatomical preparations: a great economy over the use of alcohol would result from its employment; and as the protoplasm, that is, the living substratum of the lower organisms, is destroyed by borax, the latter might be used in the treatment of wounds.—*Comptes Rendus de l'Académie des Sciences*, 1875.

APOPLEXY.

THE recent death of Henry Wilson, Vice-President of the United States, from apoplexy, lends interest to the following remarks concerning the nature of the disease, by a medical correspondent of the New-York *Tribune*.

Few persons have a right conception of the symptoms of apoplexy. The conditions constituting an attack are the rupture of a cerebral blood-vessel, and consequent hemorrhage or extravasation of blood into the brain. The effect of an extravasation of blood into the brain-substance is the same as compression by a depressed portion of the skull, because the brain is inclosed in a hard, unyielding, bony case. Under these circumstances the pressure caused by the extravasated blood interrupts the circulation in the substance of the brain, and the apoplectic phenomena, such as stupor, insensibility, etc., are in fact due to a deficiency of a proper supply of blood to the nervous mass. The mechanism is practically the same when apoplexy depends on sudden and intense congestion, or the plugging of a cerebral artery by a blood-clot.

The symptoms of the disease and immediate cause of death are, therefore, due to a lack of a proper supply of blood to the brain, and not, as is generally supposed, to an accumulation or "rush of blood to the head." It may appear paradoxical that a superfluous quantity of blood within the cranium should destroy life by depriving the mass of brain of a sufficient supply of arterial blood, yet the fact is sufficiently clear. The rupture of the cerebral blood-vessel is due to weakness of its coats, which is the result of general debility or previous ill health. In the great majority of cases there are no premonitory symptoms. The attack may be preceded, in certain instances, by a sense of weight or fulness, vertigo, flushing of the face, etc., but these symptoms are never of sufficient significance to warrant the prediction of an attack. Statistics show that of 63 cases analyzed with reference to premonitory symptoms by Rocheaux, they were present in only 9, less than 15 per cent of the whole number. The liability to an attack increases progressively from the age of 20 years upward, occurring most frequently after 60 years of age, which is due to the increased weakness of the coats of the blood-vessels in old age, and hence their liability to rupture.

It is generally supposed that an attack is usually preceded by strong mental excitement or violent physical exertion. This does not seem to be the case. Although attacks sometimes follow severe muscular exercise or mental excitement, in the large proportion of cases the affection is not induced by any obvious exciting cause. Gendrin analyzed 176 cases, and found that 97 (over 55 per cent) occurred during sleep, and a large share of the others when the patients were comparatively quiet. Another popular error is the supposition that a certain class of persons who have short necks, florid faces, with what is known as a full habit, with considerable *embonpoint*, are peculiarly liable to a so-called apoplectic constitution. Recent researches and analyses of large numbers of cases have developed the facts that no reliance is to be placed on these or any other external characters as denoting a predisposition to apoplexy, and that the majority of persons attacked are either spare or of ordinary habit of body. After a patient has suffered one attack and partially recovered, the conditions which induced it are likely to remain or to return, and hence there is considerable liability to a recurrence. Physicians therefore conclude that unless one attack has occurred there are but few if any physical signs or premonitory symptoms which will warrant the prediction of an attack in any case.

[From the Sanitarian.]

THE PUBLIC HEALTH.

MORTALITY PER 1000 INHABITANTS, ANNUALLY, FROM ALL CAUSES AND CERTAIN SPECIAL CAUSES.

POPULATION AND REGISTRATION AT MOST RECENT ESTIMATES AND DATES. 1875.	Deaths under 5 years.	Total Number of Deaths from all Causes.	Per 1000.	By Violence.	Small-Pox.	Diphtheria.	Scarlatina.	Measles.	Croup.	Whooping-Cough.	Typhoid Fever.	Typhus Fever.	Puerperal Diseases.	Diarrhœal Diseases.	Consumption.	Lung Diseases other than Consumption.
New-York, 1,060,000—4 weeks ending October 23	932	2057	25.22	97	41	186	16	4	75	32	50	4	17	224	318	230
Philadelphia, 800,000—2 weeks ending October 30	224	617	20.05	18	2	48	19	..	25	4	17	1	1	8	101	44
Brooklyn, 500,000—4 weeks ending October 30	433	860	22.36	23	57	81	13	..	45	10	15	..	4	44	120	77
St. Louis, 450,000—4 weeks ending October 30	244	584	15.87	16	9	24	23	..	16	..	20	1	3	34	51	48
Chicago, 420,000—4 weeks ending October 30	237	491	15.19	20	..	12	15	1	9	8	39	..	7	33	62	48
Baltimore, 350,000—4 weeks ending October 30	207	488	17.32	17	..	12	19	..	11	1	18	..	3	21	68	40
Boston, 341,919—4 weeks ending October 30	197	637	24.21	29	..	60	34	..	28	..	29	..	4	39	127	51
Cincinnati, 262,396—4 weeks ending October 30	170	372	18.43	17	58	10	4	2	12	3	15	..	2	25	36	28
San Francisco, 230,132—month of September	100	324	16.45	30	..	2	1	..	3	3	13	..	4	20	58	18
New-Orleans, 202,000—month of October	164	457	27.14	14	4	7	18	..	1	8	*1	..	1	18	58	29
Washington, 160,000—4 weeks ending October 30	127	283	22.99	9	..	3	1	1	1	6	15	..	4	15	47	34
Pittsburg, 140,000—4 weeks ending October 30	78	190	17.64	9	9	13	12	12	9	1	22	22	2	10	24	17
Newark, 126,000—month of October	137	324	22.11	6	..	69	3	..	9	..	4	..	2	10	52	24
Providence, 100,675—month of October	52	171	20.37	6	..	2	2	..	3	..	18	..	..	12	32	15
Milwaukee, 100,781—month of October	79	130	15.47	5	..	4	..	..	..	2	3	1	..	16	6	9
Rochester, 81,864—month of October	62	133	19.00	7	..	11	7	..	2	..	15	..	..	6	15	6
Richmond, 72,500—4 weeks ending October 30	40	106	19.00	2	..	..	..	..	4	..	5	..	..	7	14	2
New-Haven, 59,800—month of October	46	109	21.87	4	..	3	7	..	5	2	2	..	1	1	19	10
Charleston, 56,540—4 weeks ending October 23	58	119	27.36	..	..	..	..	..	..	..	..	..	..	..	..	..
Toledo, 50,000—month of October	29	37	88.80	2	..	1	1	..	4	..	2	..	..	2	2	2
Memphis, 45,000	..	..	.....	..	..	..	..	..	..	..	..	..	..	..	..	..
Dayton, 35,000—month of October	9	28	96.00	3	..	..	..	..	..	..	1	..	..	2	2	2
Nashville, 27,004—4 weeks ending October 30	47	96	46.21	4	..	26	2	..	1	1	4	..	..	13	11	3
Wheeling, 28,000—month of October	13	36	15.46	2	..	2	4	..	..	..	1	..	..	4	1	3
Elmira, 20,093—month of October	7	26	15.52	..	..	..	..	..	1	..	9	..	..	2	3	2
Knoxville	..	..	.....	..	..	..	..	..	..	..	..	..	..	..	..	..
Paterson, 39,000—month of October	49	107	32.92	4	1	43	6	..	9	..	2	..	..	2	3	4
Mobile, 40,000—month of September	33	92	27.60	1	3	..	..	..	..	..	..	1	1	4	9	2
Peru, 7000—quarter ending October 1	10	16	91.43	1	..	..	..	..	..	..	..	..	..	4	..	2
Erie, 26,037—quarter ending September 30	71	122	18.74	8	..	2	4	..	1	2	1	..	..	32	14	2
Petersburg, 18,929—month ending October 23	25	49	31.06	9	..	..	..	..	..	..	1	..	..	3	11	2

* Yellow Fever, 16. At latest dates, it had ceased.

ON THE FORMATION OF HAIL.

By M. FAYE.

THIS problem, so quiescent since Volta's time, does not seem susceptible of solution. In place of only considering the manner in which, a storm being given, hail may be formed, we must distinguish and classify the essential features of storms in general, and consider all these at once. These essential features are reduced to three:

First. The clouds, which, though they ordinarily give no indication of electrical tension, are strongly charged with electricity during storms.

Second. In these same clouds, situated at an altitude of 1200 metres, for example, above the level of the sea, at which point there reigns a temperature ordinarily above zero, are incessantly formed enormous masses of ice, inexhaustible as it were.

Third. Finally, storms are not stationary as was formerly supposed; indeed, they are far from being formed on the spot and dispersed by exhaustion. On the contrary, they travel with the extraordinary rapidity of 10, 12, 15, and sometimes 20 leagues an hour—consequently much faster than express-trains of railways. The hail-clouds having but a limited extent, they pass over a given place in a few minutes; but if hail never lasts for a quarter of an hour, it does not follow that it must cease to fall; the cloud is displaced, and reproduces further on the same phenomenon, sometimes along its entire course. When we follow the traces of a storm, we find that it did not cease to hail over an immense tract, covering the ground with several centimetres of ice, which appears as if the ice had been produced in a continuous state. These three essential points—1st, enormous quantity of movement; 2d, continued production of ice; 3d, electric tension constantly renewed, notwithstanding the incessant discharges—being established, are we to seek their origin in the lower regions, in the ascending currents formed—we do not know how—in the bosom of the lower strata of the atmosphere?

If we do so, the problem of storms will remain unsolved; for in these lower regions there exist, 1st, a complete calm; 2d, a stifling heat; 3d, an insensible electric tension. We can bring into play all the combinations imaginable, and we will not make motion out of immobility, freezing cold from stifling heat, and thunder from a total absence of electricity. It is evident enough that we must seek for electricity, cold, and motion in regions where these three essential elements of storms naturally exist. Then the problem will be to find a mechanism by which these same elements may be brought and accumulated in regions that are ordinarily deprived of them.

I. One of the most remarkable discoveries of this century is that of the continued increase of electric tension as we ascend in the atmosphere by means of balloons. It is due to Gay-Lussac. The air in the upper regions of the atmosphere is strongly charged with positive electricity, the maximum of which was not attained by that observer. The air near the earth, on the contrary, is without tension, or, if any, it is a feeble negative tension, like that of the earth. The nimbi, the altitude of which, though very variable, does not exceed 1500 to 2000 metres, gather little electricity, and in fact they are almost destitute of it; it is much higher, at 1 or 2 leagues of altitude, and higher even, that we meet with strong electric tension. We may consider our globe as being enveloped, at the heights mentioned above, with a vast mantle strongly electrified and isolated from the common reservoir by the lower strata of air. This mantle is in continued motion toward one or the other pole. In its passage, its electricity is lost in the ground by the mechanical medium of storms, and more regularly in the polar regions by the silent phenomena of the aurora borealis.

If, on the contrary, we have recourse to ascending movements for the explanation of storms, we will understand absolutely nothing of the development of electricity which is produced so continuously and with so much energy, for these currents would bring air destitute of electricity, or at most possessing a very feeble tension, contrary to that existing in the regions under consideration, and would neutralize in place of increasing it.

II. It is also in this century that ascensions in balloons have made known to us the intense cold of the higher strata, and the singular composition of their clouds proper entirely made up of icicles. Aëronauts have touched and collected fine needles of the cirrus clouds. They found the temperature at times so low as to be hardly able to measure it.

Then, these cirrus clouds are precursors of storms, and they constantly accompany them. There is no fact better ascertained by the observations of mariners and meteorologists than this concomitance. If, then, by any mechanism whatever, the upper air could be drawn, together with the frozen clouds, as far as the lower nimbi, and that in a continuous and persistent manner, we would be enabled to explain, first, the formation of the nimbi themselves, then the congealing of their vesicular water, notwithstanding the normal high temperature of these regions.

On the contrary, if we have recourse to the hypothesis of ascending currents to explain these phenomena, they will become incomprehensible; for, supposing that the passage of a temperature of 30 degrees, for example, to 24 degrees, or even to 20 and to 15 degrees, determines the condensation of the least part of their vapor, that would never determine the congelation.

III. Finally, it was again in this century that we understood the necessity of considering in its entirety the vast circulation which reigns in our atmosphere under the influence of the sun's action, and to take into account the upper currents, which we have of late begun to study by means of the cirrus which they carry. These currents float above the lower currents without disturbing their movements or their calm. They have nothing in common, at least in the immediate sense, with the lower currents, and as they have a great density and accelerated rapidity in our climates, they represent an enormous provision of force, which would not reach us if these currents had everywhere the same rapidity. However, the movement which transfers storms so rapidly must come from above, since it is there that the force and movement reside.

If, on the contrary, we assign to storms a cause placed in the lower strata, by having recourse to the hypothesis of ascending currents, is it not evident that the prodigious rapidity with which they are transferred would become an undecipherable enigma? Imagine an ascending current formed in an immovable stratum of air, like a column of smoke that rises vertically above a chimney: would it be possible to impress it in that calm air with a rapidity of movement of 15 to 18 leagues an hour? And for that column of smoke to be set in motion in a single piece, does it suffice for it to ascend until it meets with a gust of wind? But Professor Espy, whose meteorological theories still have so much influence, gives the above explanation. If we reject it, and for that it suffices to expose it in all its simplicity, to what other means will we have recourse? The question being thus reduced, by examination of the characteristic features of storms, to three simple terms, there remains but to examine by what natural mechanism electricity, cold, and the rapid movement which reign above may be brought to the lower nimbi, and even to the ground itself. The constitution of our atmosphere does not favor the sudden formation of descending currents any more than it favors ascending currents. But the difficulty will disappear, I think, for those who are willing to take into consideration gyrations toward the vertical axis, which are so frequently produced in moving fluids. These gyrations are regular phenomena, of a geometrical turn, which originate in all horizontal currents if these present persistent inequality of rapidity in their contiguous streams. Now, these conical whirlwinds have a tendency to propagate themselves downward, great in proportion to the violence of the gyration; and at the same time piercing with their points the lower strata, they travel above with the upper current in which they originated, continuously renewing themselves below.

These whirlwind movements rapidly draw downward all materials carried by these upper currents, and, in consequence, the frozen cirrus that travel there also. The needles of ice driven to the periphery because of their density, meet and agglomerate in a manner to form small opaque stones. These meeting with vesicular water in the lower clouds, congeal it in thin, transparent layers.

If, in this whirlwind movement, where the spires of various rays concentrated on the same axis have every degree of rapidity, these hail-stones pass successively from regions occupied by cold air from above to others filled with vesicular vapor, they increase in volume by successive layers until they escape, by their weight or by the effect of centrifugal force, from the action of the whirlwind.

Ordinarily these gyratory movements do not descend lower than the nimbi, where their action is exhausted by moving considerable masses of congealed water. However, if the original gyration was very intense, or if the air drawn downward was not heavily charged with cirrus, it would descend to the earth like a cloudy column, and, piercing the stratum of nimbi, would present to us the spectacle of a water-spout or a tornado. The air drawn downward would not only bring its needles of ice, it would also bring its strong electric tension. This would accumulate progressively at the surface of the cloud placed at the extremity of the whirlwind, and acquire a tension sufficient to escape in a fulgurating feature toward neighboring clouds, and finally toward the earth. The hail-storm of the 13th July, 1788, which travelled over France and a part of Northern Europe as far as the Baltic, from the south-east to the north-east, with the rapidity of 16½ leagues an hour, ravaging over two parallel bands, of 3 to 4 leagues each, an enormous space of ground, and producing devastation officially estimated in France alone to 24,000,000 francs. The hail-stones were enormous, ovoid in shape, and were armed with points; some of them attained the weight of 250 grammes. There were evidently two whirlwind movements coupled, travelling in consort with great rapidity, separated by an almost constant interval of 4 to 5 leagues, working at the expense of the unequal rapidity of the upper current, which at the time flowed in that direction, as frequently do our cyclones, storms, and water-spouts. I consider the phenomenon of waterspouts as a direct verification of this theory. If it were question of the special point of the formation of hail, if we desired to ascertain *de visu* the horizontal spiral movement of whirlwinds, which sustain the hail-stones in the nimbi, where they are formed and increased, it would be necessary to penetrate the cloud itself, for from below an opaque veil obscures all the mechanism. It would be on mountains that we might attempt such trials; but, as the neighborhood of storms is justly feared, observations of that nature are very rare. I know of but one: it was made on the 2d of August, 1835, by a learned observer, our late correspondent, M. Lecoc, on the summit of Puy-de-Dôme. At the time he made this observation, we were far from suspecting the *rôle* of gyratory movement in meteorology, and its relations did seem unintelligible at the time.

Here are two short extracts from his communication to the Academy (*Comptes Rendus de* 1836, t. II., pp. 324–329):

"I could see from afar the hail being precipitated from the lower clouds and falling to the ground. I could see it distinctly at 50 metres from the summit of the Puy-de-Dôme, just opposite me. The cloud from which it came had ragged edges, in which there seemed to be a whirlwind movement that can hardly be described. It seemed as though each hail-stone had been expelled by an electrical expulsion; some escaped above and others below, finally in all directions. After five or six minutes of this extraordinary agitation, in which the anterior border alone of the cloud seemed to participate, the hail ceased, order was again established, and the hail-cloud, which had not ceased to advance all the time, still continued its course, showing in the distance a trail of rain which scarcely reached the ground, but seemed rather to dissolve in the lower strata of the atmosphere."

A flash of lightning announced to M. Lecoc the danger of his position. He nevertheless persisted in studying the phenomenon more closely, and was suddenly enveloped during five long minutes in another hail-cloud.

"The hail-stones were numerous, and the largest scarcely attained the size of a hazel-nut. They were formed of more or less transparent concentric layers, round or slightly oval in shape; they were all animated with great horizontal rapidity. A great number struck me without hurting me in the least; they fell as soon as they touched me. The larger part of the cloud passed over my head, and I heard distinctly the hissing of the hail-stones, or rather a confused noise made up of an infinity of partial noises, that I could only attribute to the friction of each hail-stone against the air. The cloud that passed over my head, and in which all the hail was formed, did not allow it to escape but at half a league from the spot where I was standing. A small portion, however, fell upon the northern part of the summit, which intercepted its course, and I was enabled to collect a certain number of hail-stones in a bottle."—*Comptes Rendus de l'Academie des Sciences*, 1875.

AGRICULTURAL EXPERIMENTS.

THE *North British Agriculturist* publishes the minutes of a recent meeting of subscribers to the newly-formed Agricultural Association in Aberdeenshire for the conduct of field experiments, when the sites of five different experimental stations were fixed. Two of them are to be situated at Deeside, and one each at Ellon, Cluny, and Turriff, and committees were appointed for each district.

The experiments to be undertaken by the Association during the season of 1875–76 are to relate to the following questions: 1st. In what form can phosphates be most economically applied in the production of crops? 2d. What is the best season of the year to apply them? 3d. What is the value of nitrogen in the production of crops? and 4th. In what form does it give the best results? 5th. Do the same manures produce the same results on swedes and on yellow turnips? The plots are each $\frac{1}{112}$th part of an acre, or 43¼ square yards nearly. Every pound of manure or of crop in a plot is thus equal to 1 cwt. per acre. The experiments are in duplicate, two plots to each experiment, and the quantity of manure stated is that applied to each plot.

PHYSIOLOGICAL ACTION OF VANADIUM.

By JOHN PRIESTLEY.

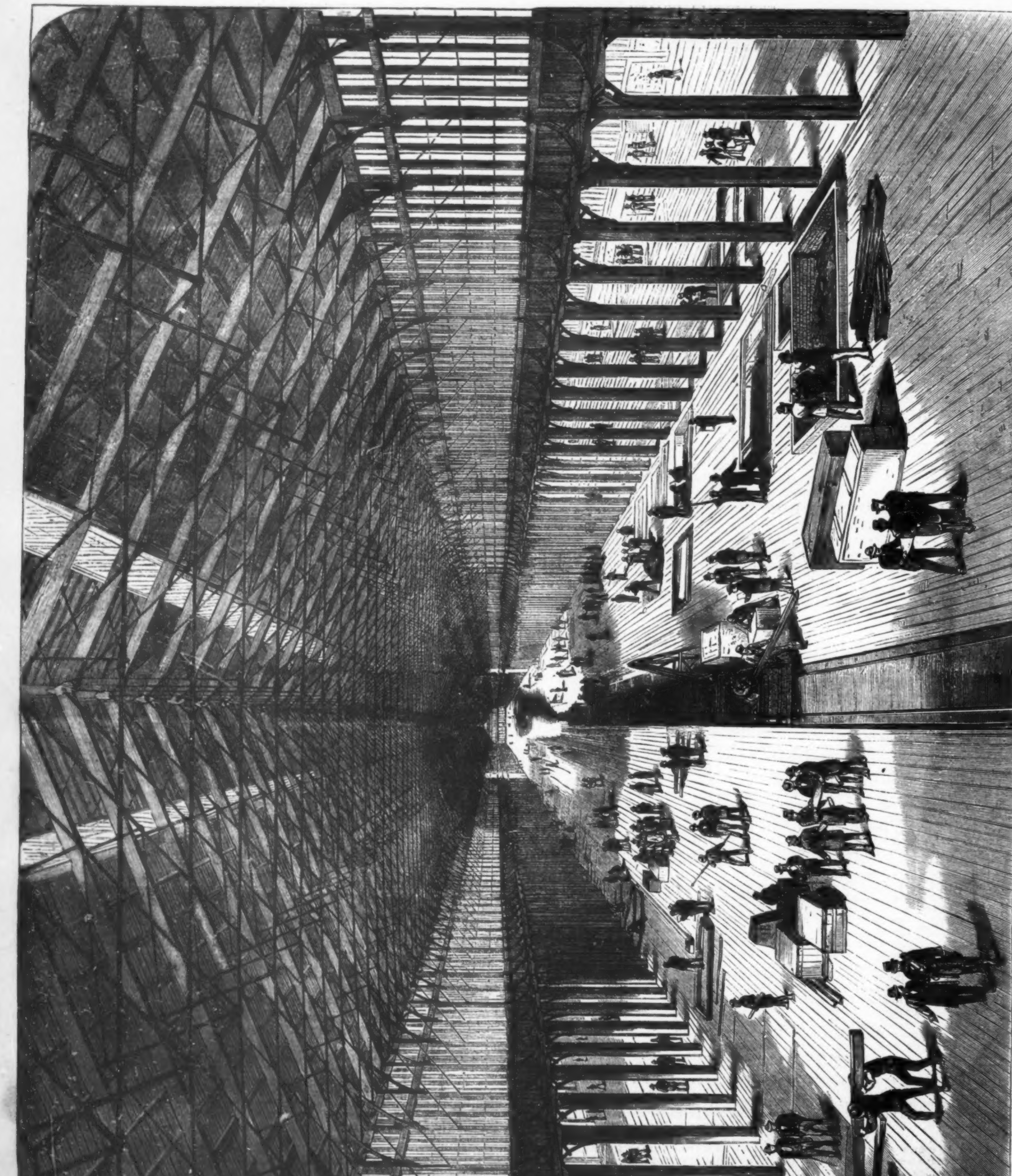
COMMUNICATED to the Royal Society, November, 1875, by Prof. Gamgee, F.R.S. Thirty-one experiments are detailed, in which frogs, a pigeon, guinea-pigs, rabbits, dogs, and cats were made use of. From these experiments it is gathered:

1. That vanadium is a poisonous substance.

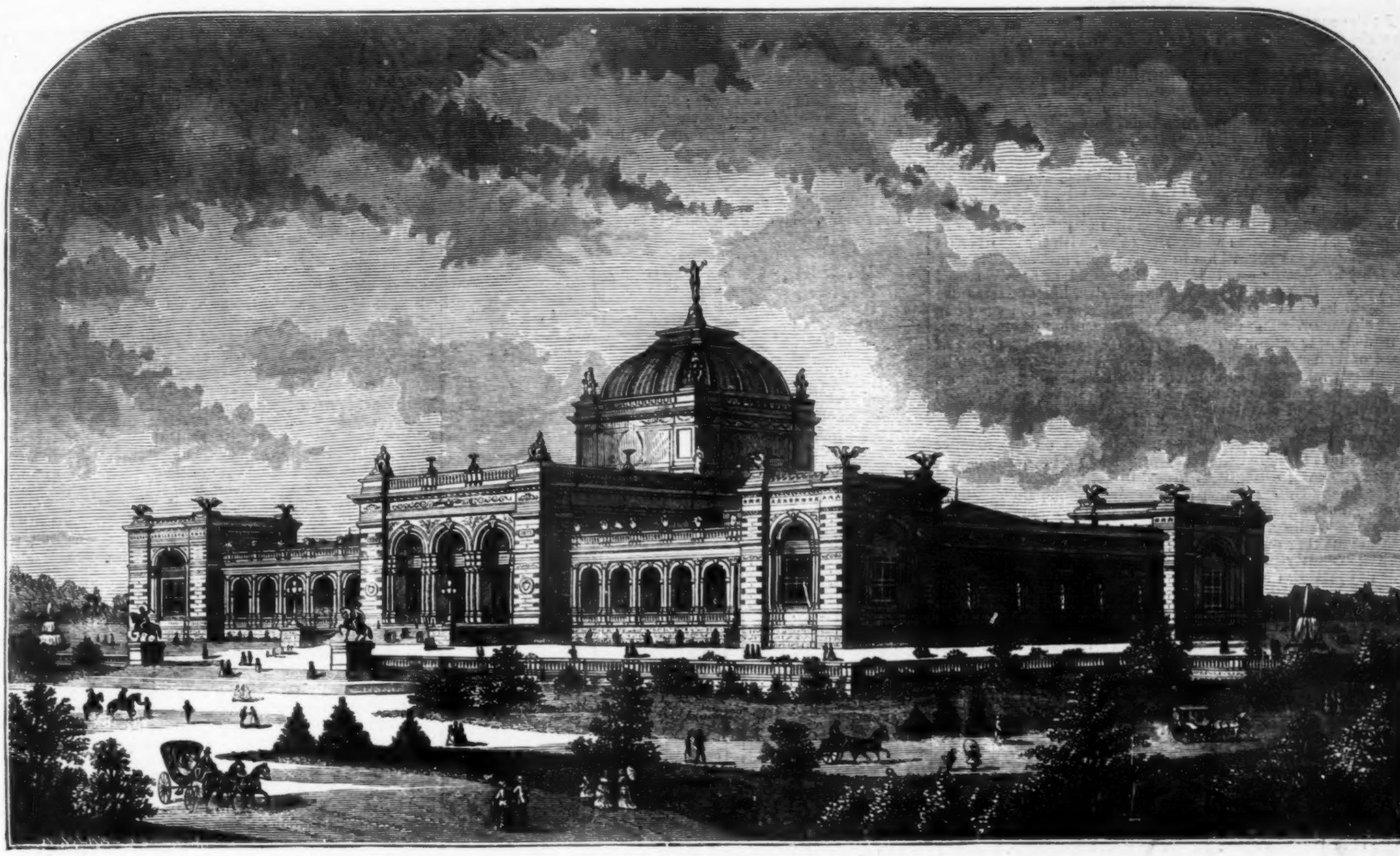
2. That the symptoms of poisoning are, in general, similar, whatever the method of the introduction of the salt into the animal system.

3. That the symptoms of poisoning which appeared in one or other of the various classes of animals above mentioned are: paralysis of motion; convulsions, local or general; rapidly supervening drowsiness or indifference to external circumstances; congestion of alimentary mucous membranes; discharge of sanguinolent fluid fæces; presence of glairy, fluid mucus in the intestines after death; certain changes in respiration, and, coincidently, a fall in temperature; drowsiness and feebleness of pulse. In addition, the heart was always irritable after death; consciousness and sensibility to pain seemed unimpaired; and no diminution could be detected in the powers of muscle and nerve to respond to stimulation.

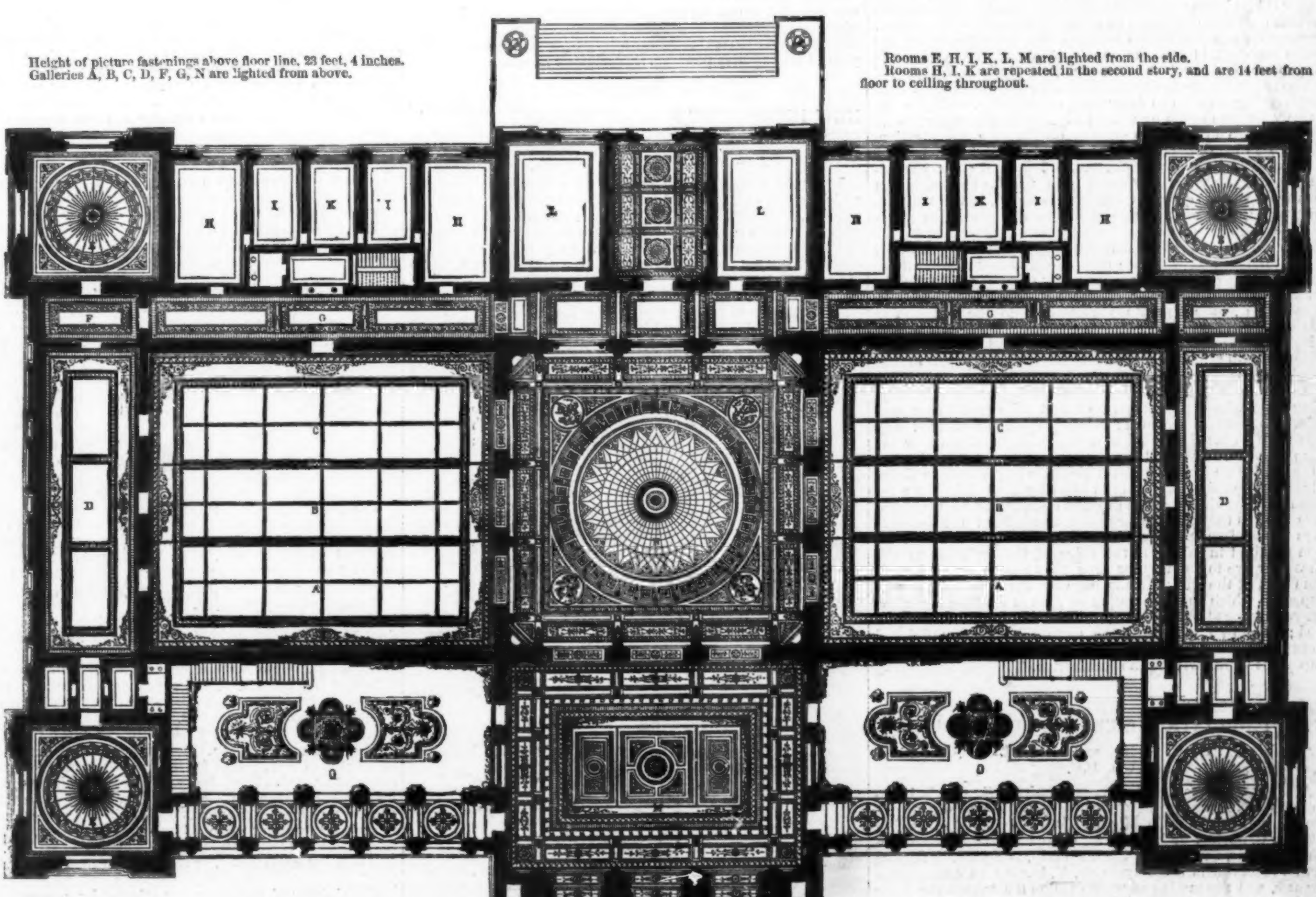
4. That the lethal dose for rabbits lies between 9.18 mgr. and 14.66 mgr. of V^2O^5 per kilog. of rabbits.



THE INTERNATIONAL EXHIBITION OF 1876.—INTERIOR VIEW OF THE MACHINERY BUILDING.—*(See page 18.)*



THE INTERNATIONAL EXHIBITION OF 1876.—THE ART GALLERY.—(*See page* 18.)



Height of picture fastenings above floor line, 23 feet, 4 inches.
Galleries A, B, C, D, F, G, N are lighted from above.

Rooms E, H, I, K, L, M are lighted from the side.
Rooms H, I, K are repeated in the second story, and are 14 feet from floor to ceiling throughout.

REFERENCES.

WALL SPACE.

A	South Halls	8680 square feet.
B	Middle Halls	7760 " "
C	North Halls	8534 " "
D	End Galleries	8248 " "
E	Pavilions	7668 " "
F	End Rooms of Corridor	2796 " "
G	Corridors	7408 " "

Height of Pavilions and Reception Hall, 52 feet.
" " Centre Hall, 77 feet.

REFERENCES.

WALL SPACE.

H	Rooms (north)	8044 square feet.
I	" "	5348 " "
K	" "	2612 " "
L	Reception Rooms	4894 " "

FLOOR SPACE.

M	Reception Hall	4956 square feet.
N	Centre "	6833 " "
E	Pavilions	5088 " "

THE INTERNATIONAL EXHIBITION OF 1876.—GROUND PLAN OF THE ART BUILDING.—(*See page* 18.)

SPECIFICATIONS.

In the course of a recent introductory lecture in opening the Engineering Classes of Glasgow University, Professor Jas. Thomson made the following remarks: "Mathematics and natural philosophy are two of the most important elements in an engineering scientific education; but they are not all that is wanted. In by far the larger proportion of cases in which important action must be taken a rough-and-ready decision is all that is wanted, or, at any rate, is all that is possible. If, however, the engineer or architect is well prepared with scientific principles to aid his judgment—if he is intimately acquainted with the physical properties of materials—if he is accustomed to take a comprehensive view of the relations and mutual influences of the different parts of structures, in numerous and varied cases, with the aid of exact mathematical investigations in cases where mathematics may be truly applicable—and if, too, his mind is amply stored with practical knowledge and experience, his decisions are likely to have more of the ready and less of the rough in their character. The designs for the execution of any important piece of work, and even for the execution of pieces of work of minor importance, in almost all cases, can not be completely made and completely exhibited by drawings alone. It is necessary also in each case for the designer to write out a specification of various particulars to be attended to in the execution of the work. The nature and scope of a specification for the execution of works must depend on the manner in which it is intended that the work shall be carried out; but, in any case, it ought at least to contain clear explanations of many things which the drawings alone do not fully exhibit, and perhaps even could not be made completely to indicate. While an architect or an engineer is proceeding with the making out of drawings for any projected work, he ought constantly to keep at hand a set of sheets of paper on which to jot down his notes for a specification; because, during the attempts to perfect the drawings many things are likely to be thought of which ought to be distinctly stated as written instructions for the builder or maker, but which, if not noted at the time, may be liable to be afterwards overlooked and forgotten. Then, when the drawings are complete, or are supposed to be nearly so, the time comes for writing out a specification in all its desirable completeness. The primary and main object of a specification may be briefly described as being to give, fully and clearly, all necessary and useful written explanations and instructions for the execution of the work; and, in the case of works to be executed by contract, for making due preparations for the effecting of a definite and clear bargain between the contractor offering to execute the work and the person or company accepting his offer. But, while this is the primary and main object, there are two incidental objects of no trivial importance, which I shall now mention: Firstly, the specification, when submitted to the person or company for whom the work is to be done, affords the best possible means for understanding the drawings, and for judging on many points in the proposed scheme, which, though perhaps of great importance, would otherwise have escaped notice; and, secondly, the requirement for a good and clear specification involves this most important condition with the architect or engineer himself—that, in fact, he can not draw it up at all without first finding out what the design or work is that he wants to specify definitely, and what parts of his project must considerately be left unsettled and open for future decision. When he applies himself with earnest determination to draw up a specification well, he can scarcely let much pass unnoticed by mere inadvertence, as he is quite apt to do when he proceeds without a specification. I have been led to make these remarks because I have learned that a practice is adopted and worked upon by many architects—worked upon very generally in the profession, it has been from various quarters strongly asserted, but I will not believe in the imputation as applied to the profession generally—a practice, namely, of giving the instructions to the builders by drawings insufficient to exhibit the work at all completely, and by what are called bills of quantities, and of arranging the bargains by means of 'price lists,' but without any writing whatever of the nature of a specification. What, then, is the obstacle that leads into the omission of this all-important means towards the complete exhibition of a design? It is ordinarily just this—that the designs themselves have neither been fully delineated on paper in the drawings, nor have been formed with sufficient completeness in any human brain. When work is begun in this way, things sometimes go forward at first with great ease and satisfaction—each person is relying upon the others; and even the architect himself has not distinctly realized how incomplete the designs and instruction he has given really are. But soon a time arrives when difficulties begin to show themselves; some things are found to be ill-arranged in their relation to other things; some things essential to be contrived have been unnoticed or forgotten altogether; the builders have to spend much valuable time that ought not to have been required in calling at the office of the architect to ask what they are to do next, or how they are to proceed with some part of the work already begun or far advanced, but in respect to which some alteration of plan is contemplated but not yet arranged or decided on. Troubles and anxieties proceed; but now I will draw the curtain over my unfinished picture of the consequences of proceeding to the execution of important works without a specification."

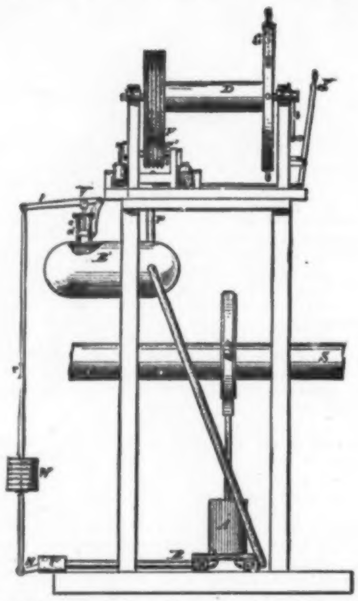
PNEUMATIC STEERING APPARATUS.

By G. W. Baird, U. S. N., and J. C. Lewis, Washington, D.C.

A, air-pump, worked by propeller-shaft S, which is revolved by the pressure of the water upon the blades of the propeller or by the main engine. R, receiving-pipe, having a valve, C, opened by handle, H, or rod *r*. R′ reservoir, in which the air, supplied by the air-pump, is stored. Attached to this reservoir is a safety-valve, V, having an outlet-opening at *e*, and the motion of whose piston *d* actuates the lever *l* and rod *r*, with weights W and cock C. The object of this safety-valve is two-fold: first, the piston rises by sufficient pressure in the reservoir and closes the cock C, thus shutting off the supply of air to the air-pump, and is thus an automatic arrangement for regulating the pressure in the reservoir; second, in case of a greater increase of pressure the piston will be raised still higher, and permit the air to escape through the opening *e*, thus forming a safety-valve. A drum, D, is mounted upon and moves freely on an axis or shaft, which may be elevated or lowered by means of the eccentrics E E′. Upon said drum is also arranged a grooved or corrugated friction-gear, F, moved by another small gear-wheel or pinion, F′, on a crank-shaft *f*, which is operated by two small air-engines, one at each end of the shaft. The ordinary ropes are used to connect the tiller with the drum D.

The engine cylinders which drive the gearing are driven by compressed air from the reservoir R′ through the pipe P. The wrench or handle *b*, for elevating the drum, or more properly for engaging and disengaging the gearing, and the lever *d′* for reversing the engine, are situated in front of the machine, where one man may manage them and observe the compass at the same time.

The operation is as follows: The vessel being in motion, and the screw-shaft S revolving, the air-pump A draws air through the cock C, and forces it into the reservoir R′. Then, by shifting the lever *d′* forward, the engines are caused to rotate, which in turn revolves the friction-gear, and moves the rudder. By pushing the lever *d′* backward the opposite motion is imparted to the apparatus and to the rudder. The lever *d′* simply reverses the engines, and,



when in mid-position, the valve-ports being closed, no air can be admitted into the cylinders.

In case the gears are pressed tightly together, and a heavy sea should strike the rudder, the engines will be pushed backward until the pressure upon the pistons balances that upon the rudder, forming a highly elastic resistance.

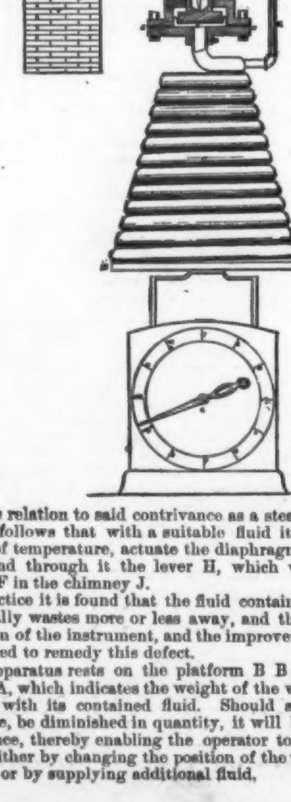
In case the vessel is under sail, the propeller-shaft S is uncoupled from the engines of the ship (as is the custom in our war-vessels), when, by pressure of the water upon the blades of the screw, caused by the vessel's speed through the water, the screw and shaft S revolve, which in turn works the air-pump that supplies power for the steering-engines.

NEW INSTRUMENT FOR REGULATING TEMPERATURES.

By A. Campbell, Woodbridge, N. J.

I employ a vessel or coil containing water or other fluid, which, when heated to a given temperature, will, by its expansion, give motion to a rod, through the medium of a diaphragm, which rod, being suitably connected with a damper in the furnace-chimney, will cause it to partially or wholly open or close, as the heat around said vessel is increased or diminished.

C is a vessel or coil containing the fluid to be acted upon by the changes of temperature. The lower end of the coil is closed. To the upper end is attached a contrivance E E E, known as Clark's regulator for controlling the fires of steam-boilers by means of steam-pressure; and as the vessel C has



the same relation to said contrivance as a steam-boiler would have, it follows that with a suitable fluid it would, by any change of temperature, actuate the diaphragm of said contrivance, and through it the lever H, which would turn the damper F in the chimney J.

In practice it is found that the fluid contained in said vessel usually wastes more or less away, and thereby deranges the action of the instrument, and the improvement now made is intended to remedy this defect.

The apparatus rests on the platform B B of the spring-balance A, which indicates the weight of the whole apparatus together with its contained fluid. Should said fluid, from any cause, be diminished in quantity, it will be indicated by the balance, thereby enabling the operator to promptly correct it, either by changing the position of the weight I on the lever H, or by supplying additional fluid.

THERMOPILES.

At the November meeting of the Physical Society, London, the President, Dr. Gladstone, in the chair, Dr. Stone read a paper "On Thermopiles." He has recently been engaged on some experiments with a view to ascertain the best alloy for use in thermopiles. The thermo-electric power of a metal or alloy appears to be quite unconnected with its power for conducting heat or electricity, or with its voltaic relation to other metals; neither does it appear to have any relation to specific gravities or atomic weights. The thermopiles employed were of a form slightly modified from that employed by Pouillet in his demonstration of Ohm's law. Alloys are frequently more powerful than elementary metals. Thus two parts antimony and one part zinc have a negative power represented by 22.70, while that of antimony is 6.96 or 9.43, and of zinc is 0.2. A strange exception, however, is that of bismuth and tin, for while the power of pure bismuth is + 35.8, when the two metals are alloyed in the proportion of twelve to one the power becomes — 13.67. Dr. Stone first used a couple consisting of iron and rich German silver—that is, rich in nickel. This was characterized by great steadiness, but the electro-motive force produced by moderate difference of temperature was not great. He then used Marcus's negative alloy, consisting of twelve parts antimony, five of zinc, and one of bismuth, but the crystalline nature and consequent brittleness of this mixture were found to be great objections to its practical use. It occurred to Dr. Stone that the addition of arsenic might diminish the brittleness without injuring the thermo-electric power, and on trial it was found that an alloy of zinc, antimony, and arsenic, with a little tin, formed a much less brittle mass than Marcus metal, with quite as great, or greater, thermo-electric power. A set of twelve couples of this alloy and German silver was exhibited. The electro-motive forces of this set, and of a similar one of twelve iron and German silver couples, were determined by Mr. W. J. Wilson, and found to be, for one alloy and German silver couple, with difference of temperature of 80° C., $\frac{1}{105}$ of a Daniell's cell. The electro-motive force of one couple of the iron and German silver set was $\frac{1}{848}$ of a Daniell's cell. The ordinary method of applying heat by a trough of hot water is objectionable, for the water short-circuits some of the current. This is evident from the fact that, if oil heated to the same temperature be substituted, a considerably greater deflection is obtained. Another method suggested by the author which would tend to economy is to allow petroleum to volatilize in the neighborhood of one face of the pile, thus chilling it, and to ignite the mixture of air and gas so produced at the other face. Clamond's pile, consisting of iron and an alloy of zinc and antimony, was employed for some time; but, although good results were obtained, the iron is liable to rust at the connections.

ON THE SINKING OF A PAIR OF IRON SHAFTS FOR AN EXPERIMENTAL AMBER MINE.

The supply of amber in commerce is mainly derived from the district of Samland, near Könisberg, in Eastern Prussia, where it occurs in a deposit locally called "blue earth," in a brown coal formation of the Tertiary age. Until lately amber was got chiefly by dredging and by collecting the fragments thrown up during heavy gales on to the sea-coast, or by shallow, irregular diggings a short distance inland. Recent geological researches having proved the continuity of the amber-bearing beds, the Prussian Government considered it desirable to start an experimental mine, to determine the conditions upon which concessions might be granted to private individuals, the right of working amber being one of the Crown privileges in Prussia.

The locality selected is at Nortyken, in Samland, where the amber-bearing bed has been found by boring to a depth of 140 feet. The section is as follows:

	Feet.
Hard blue earth, without amber................	2
Blue earth, rich in amber........................	4.9
Barren earth, no amber..........................	1

The level of the bed is 18.7 ft. below the level of the Baltic. The overlying strata, 140 ft. thick, consist of sands and clays belonging to the brown coal formation. The works planned for laying out the mine consist of two winding shafts, two bore-holes for pumping, and the necessary engines and boilers. As a large quantity of water was to be looked for in sinking, it was decided to bore the shafts and line them with wrought-iron tubes. The depth of both shafts is about 147 ft., and the distance between them is 73.8 ft.

The boring-head was a horizontal bar, carrying four chisels for cutting into the bottom of the hole, and two at each end radially for describing the outer curve of the shafts. It weighed about 17 cwt. The boring-rods of wrought-iron were of two sizes, one being an inch square, used in boring percussively; and the other 2 inches square, used when a twisting strain was applied.

The sand pumps, or shells, for removing the detritus produced in the boring, were of two sizes; the larger being 3.1 ft., and the smaller 2.1 ft. in diameter, the length in each case being 6.4 ft. They were wrought-iron cylinders with clack valves at the bottom, but the suspension was so arranged that when brought full to the surface they could be emptiep by being tipped like a bucket, without the necessity of being detached from the rods. The iron tubes lining the shafts are of best boiler plate, 0.8 in. thick, and 4.6 ft. internal diameter, in lengths of 4 ft., joined by internal rings of the same thickness and riveted. The tube is further strengthened internally by three longitudinal strips of iron of the same thickness. The bottom length of tube is of double thickness, and terminates in a cutting shoe of triangular section. The total weights of the lining tubes are 44 tons for shaft No. 1, and 45.6 tons for shaft No. 2, or rather more than 1 ton per lineal yard.

The sinking of the tubes was effected by pressure applied by screws. A cast-iron ring grooved underneath to fit the tube, and having four perforated lugs through which the pressure screws passed, was placed on the top of the tube, and the pressure was applied to the nuts by men working spanners. The lower ends of the screws were attached to a fixed point or abutment formed by a timber platform loaded with cast-iron; four screws were placed at equal distances around the circumference of the tube. The spanners were slung by tackles for convenience of manipulation, and from four to five men worked at each, so that from 16 to 20 men were employed in pressing down the cylinder. The amount of material displaced for each length of tube was about 53 cubic feet, which was removed in four or five fillings of the larger-sized shell in about six working hours. The sinking of the tube occupied about four hours, so that one complete length of the shaft tube was sunk and a fresh length slung

and adjusted for riveting in each shift of 12 hours. From the sandy nature of the ground little actual boring was required, the use of the chisels being confined to cutting through beds of shale. The work was done in day and night shifts of 12 hours, with an average of 27 men. No. 1 shaft was completed in 121 shifts, and No. 2 in 106 shifts, including both boring and riveting. The latter operation occupied rather more than half the time. The total cost of the two shafts was as follows:

Wrought-iron lining-tubes	£4093
Boring-plant	1259
Carriage	720
Labor for riveting and sinking	715
	£6787

The water-level during the sinking was constant at 32.8 ft. below the surface, the shaft being about 46 ft. above the bottom of the valley.—H. KUHN, Zeitschrift für das Berg-Hütten-und Salinenwesen.—H. B., in *Proceedings of the London Institution of Civil Engineers.*

FEEDING FARM-HORSES.

THE following very practical directions as to the feeding and keeping of farm-horses are condensed from remarks made during a very interesting discussion upon the management of farm-horses at an annual meeting of the Dalrymple Farmers' Society. Their author, Mr. Campbell, of Dalrymple, was formerly driver of the Marquis of Hasting's coach to Edinburgh, and was acknowledged to be one of the best whips in Scotland. His ideas upon stable management are therefore worthy of attention, especially at the present season of the year. The first thing to be done in the morning, Mr. Campbell tells us, "is to try each horse with water," then half a feed of corn, or, better still, a proportion of beans. All the dry straw about the horse to be put up below his manger; then the stable to be thoroughly cleaned out. The horses next to be well cleaned with currycomb and wisp as preferable to the brush for that class of horses. When the horses are thoroughly dressed over, which in all should occupy about an hour, give them another feed of oats. Then at dinner-time, we shall say 1 o'clock, the horses to be watered, and a feed of corn and forage put into their rack; racks above the horses' heads being entirely disapproved of, as it is unnatural for a horse to have his food in that position. When the horses come in at night at 5 or 6 o'clock, each man should pick out his horse's feet at the stable-door, then take them in and unharness them; if they have not had water before coming in, let them have it now; then each horse to have a small pailful of boiled food. At 8 o'clock the men must again be at the stable, and must strip themselves to give a thorough dressing, being careful with the comb about any tender places, such as behind the forelegs and inside the thighs, for fear of scratching the skin. When the men have done, the master's duty is to examine the horses to see that they are properly dressed, and if not, point it out and have it properly done. This should occupy nearly an hour. Then give another pailful of boiled food to each horse, with hay or straw in the rack again. The bed should be then made down with a little fresh litter over the top. The bed should be thinnest under the horses' feet, and gradually thicken towards the sides. The stable then to be swept and shut up for the night. It is seldom one meets with such a succinct account of stable management, and perhaps seldomer still that any such pains are taken. Farmers' horses too often have an undressed and unkempt appearance when they turn out of a morning, and the stables share the same appearance of neglect. Agricultural journals deal so exclusively with the sayings and doings of leading men that they seldom have space for commenting upon the every-day practice of the average British farmer. If the ordinary farmer, who, by the way, is the most difficult man in the world for a journalist to influence, would keep his horses according to some such careful system above sketched, taking care to be liberal in his allowance of corn, as well as systematic in giving it, we should hear less of three and four horse ploughing.

It must be confessed that our Scotch brethren who are favored with that excellent breed of horses—the Clydesdale—set us a capital example by treating them well; and, consequently, they cultivate their land with a much smaller proportional number of horses than we do in England. There are other plans of horse-feeding, each of which may have some special merit or, possibly, fault; but we venture to think that any system which enforces an abundance of nutritious food at regular intervals, properly regulates the supply of water, and keeps the horses comfortable, is worthy of attention, and may indeed be safely adopted, although with modifications suitable to the situation where it is introduced.—*Agricultural Gazette.*

FOUL FEEDING OF SWINE.

IF there is any one thing in rural practice which needs reforming more than another, it is the manner of raising and feeding swine. From the day they are large enough to eat, they are offered all manner of refuse about the place, such as rank weeds, filthy slops, spoiled vegetables and meats, dead fowls, etc. They are allowed to rummage the dung-yard, and glean the refuse of food in the fæces of cattle and horses, on the ground of economy. But we imagine that the quantity of food saved in this way is very insignificant—not to exceed the value of a bushel of shelled corn a year among the whole stock on an ordinary-sized farm. The objections to the practice of keeping swine in this way are so serious, however, that the reasons in favor of it have no force at all. The origin of trichinosis in swine may be always traced to the consumption of vile stuffs in their food, or to being housed and yarded amid filth and foul air. Every few months the press announces a case of trichinæ in an individual or a whole family, with all the horrible details and sufferings which attend the parasitic attack. Only lately some new cases are reported here in the West, which are alarming. We are quite sure that every farmer, and every one who feeds and fattens a pig, will only need to have their attention called to so important and serious a matter to secure a complete reform in the practice of feeding an animal which will take whatever is offered to it, and will live in the most filthy holes and yards. Interests as dear as health and life require a thorough reform in keeping and feeding swine. Let their food be as pure as that which other animals consume; let them be kept in clean quarters and have pure air; let diseased or unthrifty animals be separated from those in health, and we may have no fears of trichinosis among either swine or human beings.—*Detroit Tribune.*

ENGLISH AGRICULTURAL RETURNS.

THE following is a summary of agricultural returns of Great Britain for 1875, issued from the Statistical and Commercial Department of the Board of Trade:

EXTENT OF LAND IN GREAT BRITAIN UNDER

	Wheat.	Barley.	Oats.	Potatoes.	Hops.
1873	3,490,380	2,335,913	2,676,227	514,682	63,278
1874	3,630,300	2,287,987	2,596,384	520,430	65,805
1875	3,342,348	2,509,508	2,664,048	522,634	69,203

TOTAL NUMBER OF LIVE STOCK IN GREAT BRITAIN UPON THE 25TH OF JUNE.

	Cattle.	Sheep.	Pigs.
1873	5,964,549	29,427,635	2,500,259
1874	6,125,491	30,313,941	2,422,832
1875	6,012,605	29,165,278	2,228,709

[From The Academy.]

ASTRONOMY.

Catalogue of Nebulæ.—Dr. Schönfeld has published a valuable catalogue of nebulæ, of which the positions have been carefully determined by means of the ring-micrometer, applied to the eight-inch equatorial of the Mannheim Observatory. The observations are chiefly in the years 1862–64, and are a continuation of a former catalogue published in 1862. Dr. Schönfeld's original plan was to obtain at least five observations of each object, but as other observers have since taken up this important branch of astronomy, he judged it better to be content with a smaller number of measures, thus making it practicable to extend his list of nebulæ to be observed, while the attainment of a high degree of accuracy in the positions would be better promoted by the combination of results from different observers, individual errors of judgment in the estimation of the centre of an ill-defined nebula being thus, to a great extent, got rid of. In his present catalogue, Professor Schönfeld gives the places of 343 nebulæ dependent on 820 individual measures, or an average of between two and three to each object, and from a careful comparison of the separate results he concludes that the probable error of a single determination is about two tenths of a second of time in right ascension, and two and a half seconds of arc in declination. The observations were made in the usual way, by noting the difference of the times of passage of the nebula and a comparison-star across the black ring of the micrometer, and Dr. Schönfeld has taken great pains to determine with the greatest accuracy the diameters of the four rings used, while the comparison-stars have been carefully observed on the meridian by the late Professor Argelander. There appears to be a systematic difference in the right ascensions of Schönfeld's two catalogues, but this only amounts to a quarter of a second of time, which is not a large quantity where such indefinite objects are concerned, and the agreement with the catalogue of 500 nebulæ observed by Schultz is somewhat better. Dr. Schönfeld has also carefully compared his positions of individual nebulæ with those of other observers, and with very satisfactory results, the differences being generally a fraction of a second of time in right ascension and rarely exceeding five or six seconds of arc in declination. The comparison with Schultz's catalogue shows a discordance on the average of two tenths of a second of time in right ascension, and two seconds of arc in declination, so that accurate determinations of the proper motions of the nebulæ will be possible in the future if these catalogues be taken as a starting-point. This is a question of so much importance that the labor of these observations will be justly appreciated by future astronomers.

Sun-Spots and Prominences.—In a recent number of the *Comptes Rendus*, P. Secchi gives the results of the assiduous observations of sun-spots and prominences which he has made since April, 1871, during which period the sun-spots have passed from a maximum to a minimum. The following are the conclusions he arrives at:—1. The daily number of prominences seen at the sun's edge has decreased pretty regularly from fifteen to four, and the minimum appears not yet to have been reached. 2. The area of spots has also decreased, and in a more marked degree. 3. The great eruptions of metallic vapors in the sun's atmosphere have altogether ceased since the large spots disappeared. 4. The distribution of the prominences in heliographic latitude shows at the beginning of the series a minimum at the equator, and another in each hemisphere in latitude 50° to 60°, with maxima at the poles and about latitude 20°; gradually the maxima at the poles have disappeared, leaving nothing there but rather high chromosphere. 5. Though the mean height of the prominences has not diminished much, yet prominences exceeding a minute of arc in height are now very rare, though they were very frequent at first. 6. The same remarks apply to the breadth and area of the prominences. 7. The faculæ which in 1871 were most frequent near the poles are now confined to the zones of the spots, having disappeared from the polar region at the same time as the prominences, thus implying a connection with these rather than with the spots. It will be very desirable to see whether these conclusions are borne out by observations during the period of increase of solar activity which is now approaching, and P. Secchi is anxious to engage astronomers in this work.

The Mass of Mars.—Professor Asaph Hall, of Washington Observatory, has pointed out certain of the minor planets as suitable for determination of the mass of Mars, by means of his perturbations on them through the near approach of their orbits to his. Others of these minute bodies have special interest from the information they give on the attraction of Jupiter; while others, again, which approach us closely, are useful for finding the sun's parallax. The number of the known planetoids is increasing at such an alarming rate (four having been discovered in the first week of this month, and no fewer than fourteen in the present year) that astronomers are becoming alarmed at the prospect; and it is, therefore, very desirable to know which of these cosmical particles are likely to prove useful in solving some of the great problems of the solar system. The labor of computing ephemerides for, and of observing, the 154 minor planets already discovered, has become very oppressive, and some selection will probably have to be made before long. Professor Asaph Hall's investigation comes, therefore, very opportunely.

Reorganization of the Italian Observatories.—Professor Cacciatore publishes the report of the commission appointed for the above object, the conclusions at which the commission has arrived after long discussion being as follows: 1. That the observatories of Naples, Florence, Palermo, and Milan should receive the special care of the government as principal establishments. 2. That those of Parma, Modena, and Bologna be declared physico-meteorological observatories of their respective universities. 3. That those of Rome, Campidoglio, Turin, and Padua be declared university observatories dedicated to public instruction. The organization of the several observatories is to be in accordance with schemes proposed by their respective directors, and the commission hopes that if these recommendations be adopted, Italy will be enabled to contribute to the progress of astronomy in a degree second to no other nation.

The Gases from a Meteorite.—Since the discovery of the connection between comets and meteor-streams, much interest has attached to the question whether meteorites contain gases giving a spectrum similar to that exhibited by comets, and which is, in fact, that of carbon in some form. From an examination with the spectroscope of the gas obtained from a portion of an iron meteorite by means of the Sprengel air-pump, Professor Wright, of Yale College, obtained only negative results, the hydrogen spectrum being the strongest, though that of the carbon oxides was also shown, together with those of nitrogen and oxygen. No new substance was found which could be identified with any supposed constituent of the solar corona, but from the changes in the spectra of oxygen and nitrogen in the presence of hydrogen, Professor Wright was led to infer that the lines in the spectrum of the corona are due simply to hydrogen and air. Professor Wright afterwards examined a meteorite of the stony kind, which fell on February 12th, 1875, in Iowa, and this gave off a large proportion of carbon dioxide with a small admixture of hydrogen when gently heated, while at a red heat the proportions were reversed, the hydrogen being given off in much greater quantity, a circumstance which Professor Wright explains by supposing the carbon dioxide to be merely condensed on the particles of iron, while the hydrogen and carbon oxide are absorbed within it. The spectrum obtained with a small pressure was exactly that shown by comets, the hydrogen lines being overpowered by the three bright bands of the carbon spectrum, and this spectrum Professor Wright thinks might, in the case of comets, be due to solar radiations absorbed by the cometary matter, and then emitted in all directions. The results obtained lead to the following conclusions:—1. The stony meteorites are distinguished from the iron ones by having the oxides of carbon, chiefly the dioxide, as their characteristic gases instead of hydrogen. 2. The proportion of carbon dioxide given off is much greater at low than at high temperatures, and is sufficient to mask the hydrogen in the spectrum. 3. The amount of the gases contained in a large meteorite, or a cluster of such bodies, serving as a cometary nucleus is sufficient to form the train as ordinarily observed. 4. The spectrum of the gases is closely identical with that of several of the comets. A comet would thus be merely a large meteorite, or a swarm of smaller ones, giving off carbon dioxide with some carbon oxide and hydrogen, under the influence of solar heat, and these gases in streaming away would form the train visible partly by reflected sunlight, and partly by some molecular or electrical action. Professor Mallet, of Virginia, who in 1872 analyzed an iron meteorite which fell in Virginia, has since taken exception to Professor Wright's conclusions as to the difference between the iron and stony meteorites, pointing out that he found a large percentage of carbon oxide in the iron meteorite he examined, and that, though the proportion of carbon dioxide given off was less than ten per cent, yet considering how readily it is decomposed in the presence of ignited iron, it seemed probable that there was originally a much larger amount of this gas present in the meteorite. Professor Mallet's remarks, however, hardly appear to affect the main results of Professor Wright's investigations.

A MANDATE AGAINST SEALS AND SEA LIONS.

[From the Report of the California Fish Commission.]

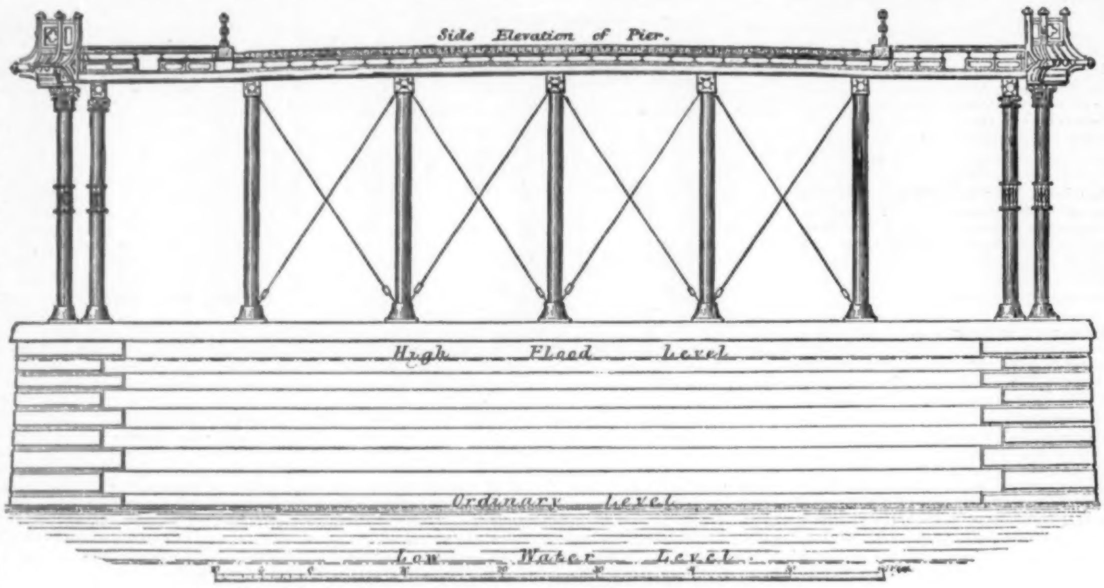
FOR many years the sea lions and seals which inhabit the cliffs near the entrance to the bay of San Francisco have been preserved by special enactment, and penalties imposed on any person who should kill or disturb them. The result is that they are probably now a hundred times as numerous as they were ten years since, and are to be found there in thousands. When it is considered that they weigh from two to five hundred pounds each, and that they consume at least from ten to twenty pounds of fish daily, it will be readily seen that the quantity caught at the entrance of the harbor and in the Bay of San Francisco by fishermen is small in proportion to that consumed by these animals. If allowed to increase at the same rate for a few more years, it will be difficult for either shad or salmon to escape them while entering our bay. The fishermen at Vallejo and Rio Vista report that they find many of the salmon to have been torn by the teeth of these animals. They appear now to serve no useful purpose other than to gratify the curiosity of strangers, and we believe it would be well if the law which now protects them were repealed, and nine tenths of them were allowed to be shot, that their oil might be utilized in the lubrication of machinery. We would recommend that this law be repealed, and, if necessary, again re-enacted after nine tenths of them shall have been destroyed.

SEPARATION OF TIN FROM ANTIMONY AND ARSENIC.

M. C. WINKLER.—If the substance is an alloy, dissolve in a mixture of 4 parts of hydrochloric acid, 1 part nitric acid, and 5 parts water, adding so much tartaric acid that the solution may not become turbid on the addition of water. If the three elements are in the state of sulphides, they are dissolved in dilute potassa; chlorine is passed into the solution, and bromine added until these two bodies are in excess. The liquid is then neutralized with hydrochloric acid, and tartaric acid is added. In either case the solution is diluted to 300 or 400 c.c., and a solution of chloride of calcium added in such quantity that the carbonate of lime precipitable therefrom may be about fifteen times the weight of the tin in the solution. Neutralize with carbonate of potash, precipitate the tin with cyanide of potassium, and finally throw down the calcium of the chloride with a slight excess of carbonate of potash. Under these conditions the tin is deposited alone, the antimony and arsenic remaining in solution. The liquid is boiled to render the precipitate of calcic carbonate more dense, and that it may imprison the gelatinous stannic acid and permit it to be washed. When the precipitate is settled it is three times washed with boiling water by decantation. If an absolutely exact separation is required, the precipitate is redissolved in a little hydrochloric acid, and reprecipitated with cyanide and carbonate of potassium as before. Lastly, the precipitate is thrown on a filter, washed, dried, and ignited to convert the stannic acid into the insoluble modification. Lastly, it is treated with hydrochloric acid, which removes the lime. The residue is then collected on a small filter, washed, ignited, and weighed.—*Zeitschrift für Analytische Chemie.*

THE GIRARD-AVENUE BRIDGE, PHILADELPHIA.

DESIGNED AND CONSTRUCTED BY MESSRS. CLARKE, REEVES & CO., PHŒNIXVILLE BRIDGE WORKS, PHILADELPHIA.



THE GIRARD-AVENUE BRIDGE, PHILADELPHIA.—FIG. 1.

GIRARD-AVENUE BRIDGE, of which we gave two engravings in our last number, and which we further illustrate in our present issue, spans the Schuylkill River in the city of Philadelphia, at the main avenue of approach to Fairmount Park and the Exhibition-buildings, and is one of the great public works that will interest visitors to the Centennial Exhibition. Our engravings and the following are from *Engineering*.

It is remarkable as the first attempt in the United States to combine the American system of pin-jointed, open-work girders, distinguished for their lightness of appearance, with a solid roadway of stone, constructed in that massive and substantial manner which is customary in England and on the Continent. To this is added a higher degree of architectural ornament than is common even here.

Its dimensions and cost do not differ much from our recent first-class bridges over the Thames, as will be seen from the following table:

NAMES.	Length.	Width.	Square Feet of Surface.	Cost.	Cost per Square Foot.
				£	£
London............	904	53½	47,364	542,150	11 0
Waterloo..........	1380	41½	57,270	579,915	10 0
Southwark.........	800	42½	34,000	384,000	11 0
Westminster.......	1160	85	98,600	393,190	4 0
Blackfriars........	1272	76	96,672	320,000	3 6
Girard............	1000	100	100,000	267,500	2 13

The height of the roadway above low water is 55 ft. The girders rest on three piers and two abutments, and form three centre spans of 197 ft. each, and two side spans of 137 ft. each. The height of the lower chord above low water is 23 ft. The bridge has a camber of 18 in. in its total length.

Foundations.—The foundations of each pier were constructed as follows: The debris was removed from the rock-bed of the river 30 ft. below low water, by the common American single-bucket steam dredging-machine. A double-walled bottomless caisson, 34 ft. wide by 156 ft. long, having the ends pointed, and formed of foot-square timbers well bolted together in the usual American manner of forming "cribwork," was sunk upon the bare rock, its bottom timbers having been carefully scribed to fit the inequalities of the surface. The spaces between the double walls were then filled with loose stone. The top of this cribwork came to within 16 ft. of the surface of low water. The sides were then carried up by means of upright timbers placed 6 ft. apart, and planked with 2-in. plank. This formed a cofferdam, not strong enough to be pumped out, but capable of excluding the current of the river, even during freshets, and of forming a pool of still water through which the concrete could be lowered without its cement being washed out. This dam was carried 20 ft. above low water, or above the level of the highest floods. All this work above the crib was temporary, and removed after the construction of the pier. The internal space of the crib was then cleared by divers, using a centrifugal pump, which sucked the rock clean.

This interior space, 22 ft. wide by 137 ft. long by 16 ft. high, was then filled with béton made as follows: Furnace slag was broken up by a Blake crusher, so as to pass 2-in meshes. By placing this in a measured barrel of water the proportion of voids to solids was found to be exactly as 1 to 2.

A mortar was then made of one part of Pennsylvania hydraulic cement from the Coplay Works, and one part of clean sharp sand, the mixture standing thus:

Voids filled ..	1	=	{ 1 part Coplay cement. 1 part sand.
Solids	2	=	{ 4 parts crushed furnace-slag.

This béton was mixed by hand on platforms, until each stone was thoroughly coated with mortar. It was then lowered in a box so constructed as to quite protect it against wash during descent, and easily discharge it after touching bottom. It was laid in 12-in. deep courses, carefully levelled by divers. This béton bore by test 308 lb. per square inch on cubes 3 in. square, after 30 days' immersion. The extreme pressure from bridge and maximum load is 45 lb. per square inch, or less than 3 tons per square foot. No sign of settlement or cracking has shown itself in any part of the structure.

The foundations of the abutments were made in a similar manner, except that a cofferdam of 12-in. by 12-in. sheet piles took the place of the cribwork caissons, and the earth was removed by a clam-shell dredge of the pattern so successfully used by Mr. C. S. Gzowski, at the International Bridge over Niagara River.

The masonry of the piers and abutments is rock-faced ashlar of Maine granite laid in mortar of one part Coplay cement to two parts of sand. The courses are from 20 in. to 30 in. high, stretchers from 5 ft. to 7 ft. long, with as much bed as rise. There is one header to every two stretchers reaching into the pier more than half its width. The courses bond on each other not less than their depth. The backing to this face-work is of concrete, made as heretofore described. The copings and parapets are of finely cut granite, but no other cutting has been done, except the necessary drafts, the object being to preserve the massive effect of rock-faced granite work.

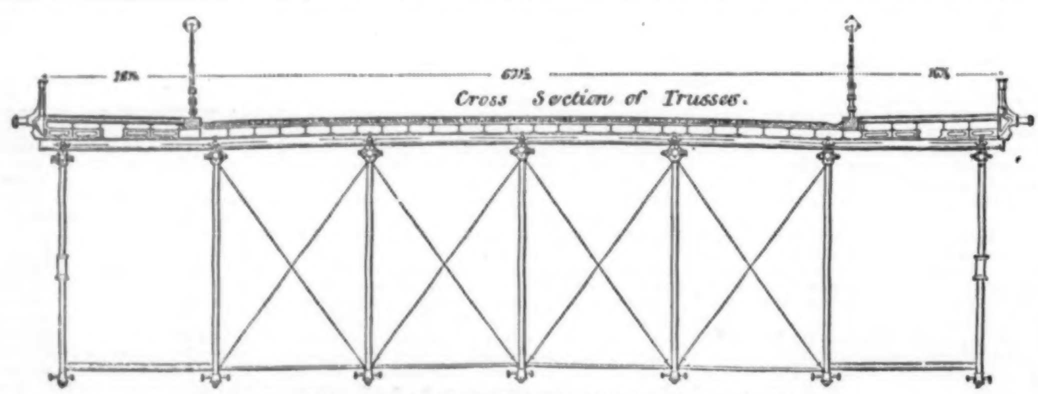
Superstructure.—There are seven lines of trusses or girders placed side by side 16 ft. apart, and united by horizontal and vertical bracing.

These trusses are of the well-known Phœnixville pattern of quadrangular girder. The upper compressive members and the vertical posts are Phœnix flanged columns, united by cast-iron joint boxes. The lower chords and diagonals are Phœnix weldless eye-bars, die forged by hydraulic pressure. Upon the tops of the posts, 12 ft. apart, are laid heavy 15-in. Phœnix rolled beams, and upon these longitudinally 9-in. beams placed 2 ft. 8 in. apart. These are covered transversely with rolled corrugated plates ¼ in. thick, corrugated 1¼ in. high by 5 in. wide. These form an unbroken iron platform upon which the asphalt concrete is placed.

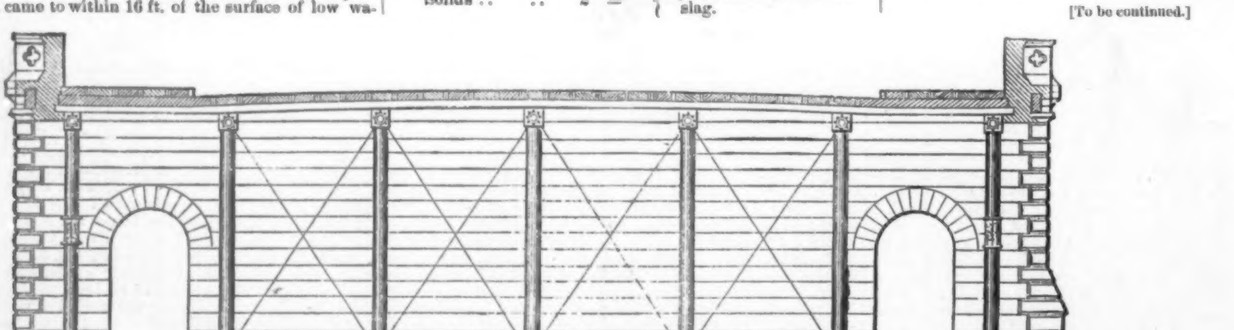
The dead load of the structure with a moving load of 100 lb. per square foot makes a total load of 30,000 lb. per lineal foot, carried by seven trusses.

The limit of strain is 10,000 lb. per square inch, reduced to 6000 lb. per square inch as the compressive limit on parts.

[To be continued.]



THE GIRARD-AVENUE BRIDGE, PHILADELPHIA.—FIG. 2.



THE GIRARD-AVENUE BRIDGE, PHILADELPHIA.—FIG. 3.

IMPROVEMENTS IN THE MANUFACTURE OF ILLUMINATING GAS FROM PETROLEUM.

By T. S. C. Lowe.

[Extracts from a recent report by Professor Henry Wurtz.]

The Lowe process belongs to that general class of water-gas methods which has always been held by chemists who have given their attention to the subject (including the undersigned) to involve the greatest number of elements of ultimate practical success—namely, that class in which mixed hydrogen and carbonic oxide gases, produced by the action of steam upon carbon at an intense temperature, are afterward combined with richly carburetted gases, to communicate illuminating power. Petroleum is, in this case, the source of the richly carburetted gases.

In a report of the undersigned, made to the Manhattan Gas-Light Company of New-York City, in 1864, eleven years since, the ground was taken that practical success in this class of methods, *economy* being taken for granted, was at that time dependent mainly upon the attainment of two points, namely, the reduction of the *carbonic acid* in the water gas to a manageable proportion, and *uniformity* of quality and candle-power in the final product. This view is just as sound now as then; and my investigations were directed, among many other things, to the settlement of these two questions.

THE METHODS AND APPARATUS.

These are essentially founded upon patents granted to T. S. C. Lowe.

The accompanying cut represents a section of one of the sets of apparatus, of which *four* are erected at Utica, although only two are, at the present season, kept at work; these being more than sufficient to supply the consumption of the town, which, during the month of October, 1875, was close upon 120,000 feet per day.

On the left of the cut is represented the gas-generator, 9 feet high and 28 inches in internal diameter, half filled with clean anthracite, broken to rather large "egg size." P indicates the man-hole for feeding the coal, almost flush with the second floor of the building on which the attendant stands. The apparatus next on the right is called, by the inventor, the "superheater"—a name which we are obliged to use provisionally, though its functions are but imperfectly expressed thereby, being rather those of a *regenerator*. The dimensions of the superheater are 15 feet in height by 28 inches internal diameter.

The first step in the process consists in blowing up the anthracite in the generator to intense ignition, by means of a blast of air entering under the grate *g*, at the point marked by the arrow. The highly heated gaseous products, consisting of carbonic oxide and nitrogen, pass down through pipe *f*, and meeting in *g* another blast of air from the right, kindle again and blaze up through the mass of loose firebricks in the "superheater," heating the latter to an intense temperature. On one occasion during my investigation, one of these columns having been out of use for ten hours, since the last passage of the gas through it, I had an opportunity to view its interior from the top, and found the heat to be still a bright cherry red, near 2000° F. During the first stage of blowing up the generator, the valve *h* at the top of the superheater is open, and the blast passes on to the boiler to help make steam.

The second stage is to shut off the air-blast, to close the valve *h*, and to introduce steam into the side of the generator, through the small pipe marked "steam" passing down its right-hand side.

Water-gas is now formed, and there is simultaneously fed into the top of the generator, trickling slowly in through the small syphon-tubes *m*, a certain amount of crude petroleum, of ordinary density, which, vaporized by the heat as it enters, is swept on to and through the superheater, in which it undergoes gasefaction; and the whole mixture passes on through *n*, down to the washer *v*, and on to the other arrangements provided for condensation. The amount of gas obtained at each heat is 3000 cubic feet or more, according to the degree of heat attained, and the average time of each such heat, including both stages of blowing up the fire and generating the gas, is one hour; so that 24 heats, or over 70,000 cubic feet of gas, can be obtained daily from each apparatus.

THE ANALYTICAL RESULTS.

To obtain a knowledge of the chemical nature of the crude gas, as it issues from the "superheater," I attached one of my newly-invented analytical trains (described in the *American Chemist* for March, 1875) to one of the mains at the point where it bends down to pass to the washer. This point was about 16 feet distant, horizontally, from the superheater (the relative distance being shortened in the cut), but the heat was so intense, that on inserting a chemical thermometer, ranging up to 500° F., through a vulcanized stopper, the rubber soon melted, and the thermometer was broken. A common cork was then tried, with a glass tube inserted through it, through which to draw off the gas. This becoming almost instantly stopped, was found, on being withdrawn, to have become *fused* and collapsed at the extremity; indicating to my surprise a temperature of at least 1200° F. in the gas at this point. It was found necessary, therefore, to have an iron tube, about one inch diameter and forty inches long, screwed into the main, in order to form a connection. The gas was then passed slowly through my apparatus, which condenses all the impurities, separating them into eight separate and distinct constituents, as set forth in column (A.) of the accompanying tabulation (see table). Column (B.) represents the figures obtained by the simultaneous application of a similar apparatus to the gas after it had passed the washers, and column (C.) the like figures obtained from the same identical gas in a like apparatus attached between the purifying boxes and the station meter. The columns (A'.), (B'.) and (C'.) represent the proportions, in *volumes* per 100, of the different impurities, at these three different stages of the process. I should here state that as these three analytical trains were kept at work during many hours, and throughout the course of a number of successive "heats," these figures represent a just average of the gas as manufactured at this date, October 16th.

In his remarks upon the analysis, Prof. Wurtz gives many interesting observations, from which we extract the following:

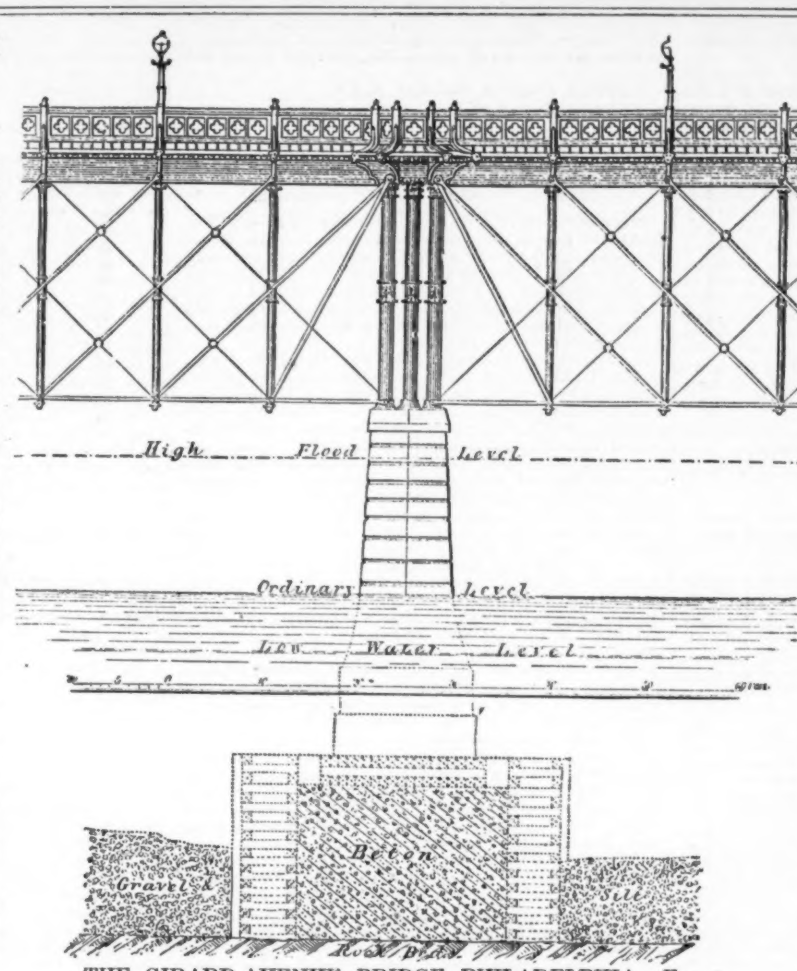
The very small amount of ammonia in this gas at once commands attention, being not more than one fifth or one sixth of that which occurs in crude gas from an ordinary coal-gas.

The sulphur is also very small compared with ordinary crude coal-gas, being about one third the amount in that from a first-class Westmoreland coal, and not more than one fifth of that I have found in some West-Virginia gas-coals. The amount of carbonic acid, as was to be anticipated, rises much above that which is found in gas from gas-coal, but not so much so as to render purification by lime more than ordinarily difficult.

At the Harlem Gas Works, the amount of tar, soot, and naphthaline, in the crude gas, as it came from a main connected with the general hydraulic main—part of the tar having, of course, been already condensed, the coal used being very rich gas-coal from West-Virginia—was 86.2 per cent.

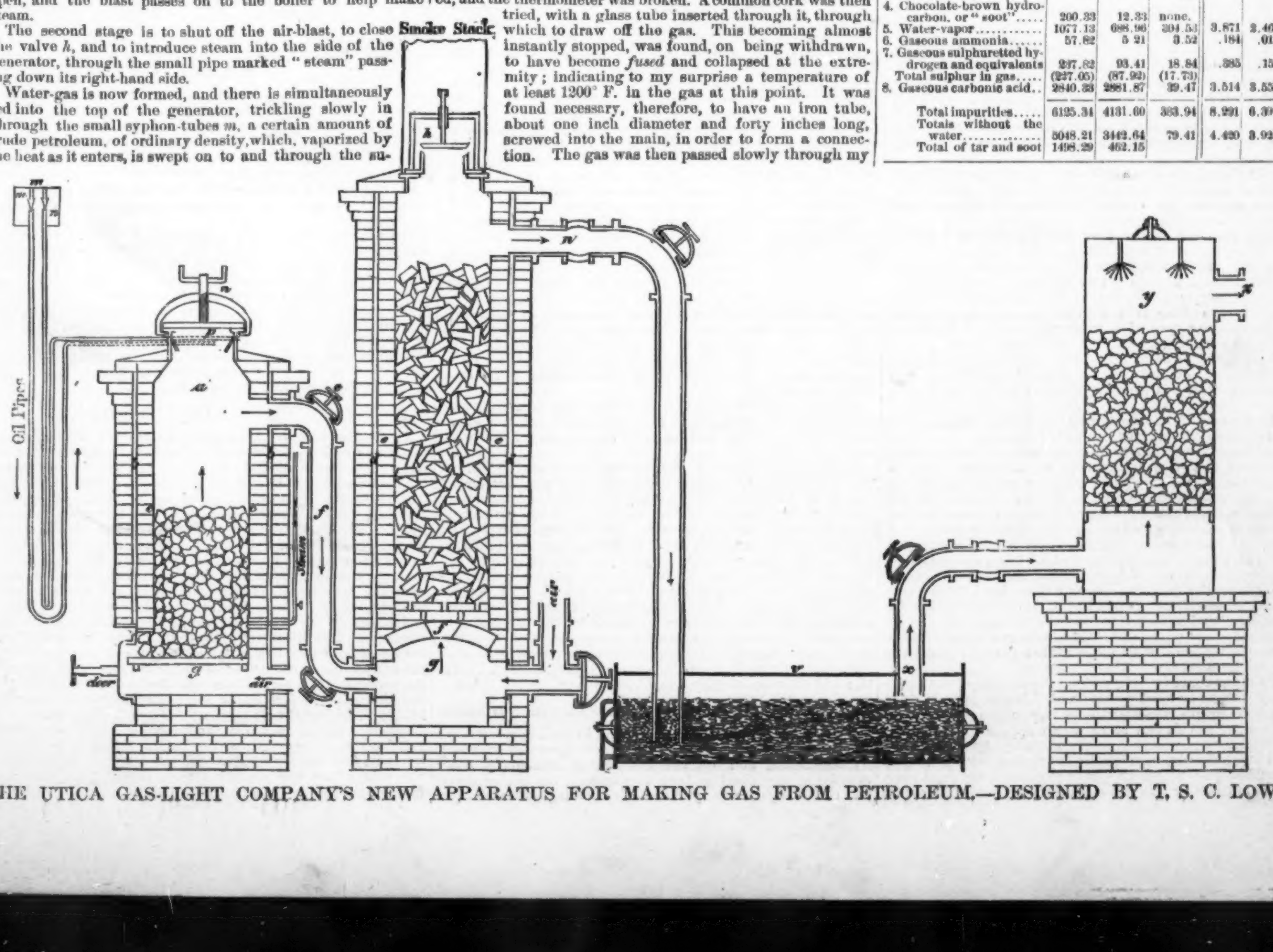
In the case at Utica, the percentage of tar and soot condensation, by cold-water scrubbing, was but 59.5 per cent in all.

But this is not the whole story. The flow of gas through the St. John apparatus, at the time of my analyses, at Har-



THE GIRARD-AVENUE BRIDGE, PHILADELPHIA. Fig. 4.

Table I.	Crude gas.	Condensed gas.	Purified gas.	Crude gas.	Condensed gas.	Purified gas.
October 16th, 1875.	(A.)	(B.) WEIGHTS. Grains in 100 cubic feet.	(C.)	(A'.)	(B'.) VOLUMES. Cubic feet in 100.	(C'.)
	Temperature Fahrenheit.					
	About 80°.	53°.	56°.			
1. Tar in spray, mechanically suspended	355.29	......	......			
2. Water in spray, mechanically suspended	413.95	......	......			
3. Condensable tarry vapors, with a little naphthaline	942.67	449.82	none.	.337	.211	
Dust of lime, etc	....	......	17.58			
4. Chocolate-brown hydrocarbon, or "soot"	200.33	12.33	none.			
5. Water-vapor	1077.13	688.96	304.53	3.871	2.469	1.092
6. Gaseous ammonia	57.82	5.21	3.52	.184	.017	.011
7. Gaseous sulphuretted hydrogen and equivalents	237.82	93.41	18.84	.385	.150	.030
Total sulphur in gas	(227.05)	(87.92)	(17.73)			
8. Gaseous carbonic acid	2840.33	2881.87	39.47	3.514	3.550	.049
Total impurities	6125.34	4131.60	383.94	8.291	6.397	1.182
Totals without the water	5048.21	3442.64	79.41	4.420	3.928	0.099
Total of tar and soot	1498.29	462.15				



THE UTICA GAS-LIGHT COMPANY'S NEW APPARATUS FOR MAKING GAS FROM PETROLEUM.—DESIGNED BY T. S. C. LOWE.

less, was some 20,000 feet per hour, or at least four times that through the Utic. scrubbers.

The sooty matter, an important bugbear that has haunted gas-circles, in connection with the use of petroleum as a gas material, is completely laid at rest by these analyses, especially when considered in connection with the figures above quoted from the West-Virginia gas-coal at the Harlem Gas Works. I refer to a subject of common report, credited by many not familiar with the facts, that in all gas made from petroleum a special amount and kind of *lampblack* or *soot* is inherent, which it is impossible to separate altogether by any mode of condensation, or even of purification. It was found, however, that in this process at least, the amount of sooty matter is less in proportion than with the coal-gas, being about 2 grains per cubic foot against 2.7 grains; and it will be observed, moreover, that in the condensation there was a very much closer separation of the petroleum soot than of the gas-coal soot, about 94 per cent against 79 per cent. The residual soot in the condensed gas was entirely separated in the lime-boxes, staining the lower tiers of trays quite brown. An interesting fact is the somewhat light chocolate-brown color of this peculiar hydrocarbon, while the soot from the coal-gas was nearly black, like ordinary chimney-soot.

STATISTICS OF MATERIAL AND PRODUCTION.

During the month of September, 1875, the record foots up *weekly* as follows:

September, 1875.	Oil; gallons.	Coal; pounds.	Labor; dollars.	Make; cubic feet.
1st to 7th, inclusive	2.166	43.389	$60.09	710.900
8th " 14th "	2.060	44.024	60.09	693.400
15th " 21st "	2.156	51.315	60.09	710.000
22d " 28th "	2.317	50.407	60.09	755.900
29th " 30th "	758	13.900	17.19	250.400
Total, 30 days	9.477	203.035	$257.55	3.050.600
Average per day	315.9	6.767.8	8.55	101.397
Per thousand feet of gas	3.107	66.56	0.0844	

Of the above anthracite, the amount used for steam-making alone was 63,722 lbs., or 31.38 per cent, leaving, as the consumption of anthracite in the generator for heating it and making the gas, 139,313 lbs., or 45.66 lbs. per 1000 feet of purified gas. The amount of lime used during September was 874 bushels, costing ten cents per bushel, and the labor in the purifying department cost $38. This makes the cost of purification during September 4.11 cents per thousand.

During the first 16 days of October, during and up to the time of closing my examinations and analyses, the figures were as follows:

	Oil.	Coal.	Make.	Lime slacked.	Labor in purification.
	6.021	122.378	1.893.500	384 bush.	$14.25
Per 1000 feet	3.15	64.63		0.204	0.75.3

According to this a great and rapid advancement appears in the management of the purification, the cost per thousand for labor and time together being but 2.783 cents. There appears no reason, so far as I can ascertain, why this low cost of purification should not be maintained.

CHARACTER AND QUALITY OF THE GAS.

The beauty and brilliancy of this gas was a common topic of observation and remark in Utica. The temperature of several nights was below freezing; and in one of them snow fell, but the author could observe no effect on the gaslight.

The candle-power of this gas, during the period of the analyses, was *nineteen* and a *half* (19.5) candles for five cubic feet per hour.

Density.—This was carefully determined, and found to be, mean of three determinations, .571. This is remarkably low for a gas of this composition and origin, and would appear to indicate that the petroleum must be at least partially converted by this method into gases of a lower density than are usually obtained from it.

GENERAL CONCLUSIONS.

1. The Lowe process, as operated on an ample working scale—120,000 cubic feet of gas per day—at Utica, constitutes an exceedingly *compact* and *efficient* apparatus, occupying very small ground-space, for evolving water-gas from anthracite coal and steam, with surprising rapidity.

2. The average amount of *carbonic acid* in the completed illuminating gas is reduced by this method to three and a half per cent, a proportion readily manageable by ordinary lime purification.

3. The practical result is a complete and reliable *uniformity of quality* of the gas for weeks together, quite comparable with that obtained in a well-regulated ordinary coal-gas works.

4. The amount of *gas-tar* produced per thousand feet of finished gas is but one fourth that from gas-coal.

5. The amount of sulphur in the finished gas is but one third that from a first-class gas-coal, and hence, notwithstanding the larger proportion of carbonic acid, complete purification with lime is not more troublesome or more costly than in the case of a good gas-coal—one bushel of slacked lime purifying about 5000 cubic feet of gas.

6. The amount of ammonia is but one fifth that in coal-gas, and hence the fouled lime from the purifier is very much less offensive and troublesome than in the case of coal-gas.

7. The amount of naphthaline is small, and can not, with proper tar-condensation, give rise to any trouble.

8. Enrichment with about three gallons of petroleum to the thousand feet of gas furnishes, by this method, a perfectly permanent gas of between nineteen and twenty candle-power; and it is probable that if the tar-condensation can be effected without contact with cold water, a somewhat less proportion of oil may give the same illuminating value.

9. The current cost of nineteen and a half candle-gas, delivered into the holder, inclusive of all labor and materials (not inclusive, however, of interest, salaries, taxes, repairs, etc.), is admitted to involve a saving of at least 35 per cent over that of gas from gas-coal of a much inferior quality and smaller actual money value to the consumer.

10. The density of this 19 to 20 candle-gas was not above .571, comparing well with some cannel gases of but little higher candle-power.

11. So far as could be judged, from the absence of testimony to any poisonous or morbific action of this gas, at least upon men in good health, the anticipated importance of the objections to water-gas on this score would appear to have been much exaggerated.

12. I must, finally, sum up by expressing with emphasis the gratification with which I have recognized the solid progress that is made by this successful process, in realizing what I have long awaited as a real step in the arts of civilization—the cheap manufacture of combustible gas from carbon and steam.

12 HUDSON TERRACE, HOBOKEN, N. J.,
Nov. 1, 1875.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY. LONDON, NOVEMBER.

PROFESSOR ABEL, F.R.S., President, in the chair.—The President said he was happy to announce that they had almost completed the furnishing of the laboratory with apparatus for the purpose of illustrating the papers brought before the Society, and hoped it would add considerably to the interest of them. They had received a present of a balance from Mr. Longstaff, and from Dr. Frankland a Sprengel pump, with the necessary quantity of mercury.

The Secretary read a paper "On Ethyl-Phenyl-Acetylen," by Mr. T. M. Morgan. The sodium-derivative of phenyl-acetylen, a hydrocarbon discovered some years ago by Glaser, when treated with ethyl-iodide, yields a product from which a colorless liquid, ethyl-phenyl-acetylen, may be isolated by careful fractional distillation. It boils at 201° C., and combines with hydrobromic acid. The mono-bromide thus formed, when digested with sodium acetate and subsequently treated with potassium hydrate, gives an alcohol of the formula $C_{10}H_{12}O$, and boiling at about 225° C.

Dr. C. R. A. Wright read a communication "On Narcotine, Cotarnine, and Hydro-Cotarnine," by himself and Mr. G. H. Beckett. The action of water on narcotine hydrochloride is similar to that on the narceine salt, splitting it up into hydrochloric acid and basic salts. The action of ethyl-iodide on hydro-cotarnine produces a compound of the formula $C_{12}H_{15}NO_3,C_2H_5I$, and this, when decomposed by silver hydrate, yields a strongly alkaline solution which absorbs carbonic acid from the air. This resists the further action of ethyl-iodide, so that hydro-cotarnine is a nitrile base, and its formation from cotarnine is parallel with that whereby acetylen is converted into ethylen. The prolonged action of ethyl-iodide on narcotine completely converts it into the ethiodide, but the product is not crystalline and is readily decomposed; the authors, however, succeeded in obtaining a platinum salt. Similar results were obtained with cotarnine, but the resulting compounds are more stable. The action of acetic anhydride on narcotine, cotarnine, and hydro-cotarnine were also tried, but with negative results.

There are two appendices to this paper, one "On the Physiological Action of the above-mentioned Ethyl Compounds," by Dr. F. Pierce; the other, "On the Structural Formulæ of Narcotine and its Derivatives," by Dr. Wright; in which, after reviewing the work of Matthiessen and Foster on this subject, also that of Liechti, he arrives at the conclusion that the formula of opianic acid is that indicated by Liebermann and Chojnacki—

$$C_6H_2(OCH_3)_2(COOH)\,(COH),$$

and consequently the structural formula of narcotine is

$$(COH)\,(OCH_3)_2C_6H_2 — CO — [C_{11}H_{11}\,(CH_4)O_3]—N.$$

Dr. Armstrong, after remarking that Dr. Wright had not given any evidence in favor of the formula

$$C_6H_2(OCH_3)_2(COH)\,(COOH)$$

for opianic acid, said that some months ago he had stated before the Society that he had found that opianic acid, when heated with zinc chloride, yielded vanillin—

$$C_6H_3(OCH_3)\,(COH)\,(OH),$$

and had thence deduced the formula for opianic acid given above.

Dr. Wright replied that he hoped shortly to lay before the Society Part III. of these researches, which contained the evidence for the formula of opianic acid; and the speaker then briefly stated several reactions which he had observed which tended to support the view that this formula represented our knowledge of the subject, especially the relation which exists between pyrocatechin and hemipinic acid on the one hand, and protocatechuic acid and opianic acid on the other.

Mr. W. Noel Hartley then read a paper "On the Presence of Liquid Carbon-Dioxide in Mineral Cavities." The author, after summarizing what had already been published on this subject, especially noticing the observations of Davy and Brewster, described his experiments on a microscopic specimen of quartz with fluid cavities obtained from Mr. Norman. He observed that, on heating the specimen to 36° C., the liquid disappeared completely, but returned on cooling; a determination of the critical point was, therefore, made, and was found to lie between 30.75° and 31° C. Andrews's determination of the critical point of carbon dioxide places it at 30.92° C., so that there can be no doubt as to the nature of the liquid in the quartz cavity examined. After the meeting the author exhibited the specimen described.

The President, in thanking the author, observed that his application of Dr. Andrews's method was of great interest, and likely to throw considerable light on the nature of the liquids in the cavities of various minerals.

Mr. Field said it was very curious that quartz with these cavities was only found in certain districts; for instance, he only knew of two in the north of Chili, and in Cornwall, which was peculiarly rich in large quartz crystals, they were only found in the mine De la Bole, near Bos Castle. Mr. Talling told him he once possessed a cubic crystal of quartz, a pseudomorph, which contained about a fluid ounce of a liquid in a cavity.

Professor Church had a crystal of fluor-spar from Cornwall which formerly belonged to Sir David Brewster, and which had a cavity nearly half an inch long, partly filled with liquid.

The last paper was "A Preliminary Notice on the Formation of Coumarin, Cinnamic Acid, and other similar Acids," by Mr. W. H. Perkin. The author found that coumarin may readily be prepared by boiling salicylic aldehyde with acetic anhydride and sodium acetate. By treating benzoic and other aldehydes with the same reagents, they are found to yield acids, and, moreover, by varying the anhydride and the salt, a great variety of new acids can be obtained. Succinic anhydride and a succinate, when heated with benzoic aldehyde, also gives a beautifully crystalline acid. The following acids have already been prepared by this process and analyzed: Cinnamic acid, $C_9H_8O_2$; α and β methyl-oxycinnamic acids, $C_9H_7(CH_3O)O_3$; phenyl-crotonic acid, $C_{10}H_{10}O_2$; phenyl-acrylic acid, $C_{11}H_{10}O_2$; cumenyl-acrylic acid, $C_{12}H_{14}O_2$; and cinnamyl-acrylic acid, $C_{11}H_{10}O_2$.—*Chemical News.*

ROYAL SCOTTISH SOCIETY OF ARTS. EDINBURGH, NOVEMBER.

MR. ALEX. GOWANS, Vice-President, in the chair.—Mr. W. A. Carter, C.E., read a paper on "Domestic Sanitary Arrangements, and on the Disposal of Sewage." After describing the usual water-closet system, the reader dwelt on the danger arising from the forcing of sewer-gas from closets into houses by the ebb and flow of sewage, thermometric and barometric differences and currents of air. Having referred to the absurdity of the supposition that ordinary traps would hold dangerous gaseous forces in check, he showed by means of a model the ease with which ordinary air-pressure could force these traps, and then described various inventions which had for their object the obviating of this danger. He preferred a single trap with ventilating air-pipe to a double trap with an air-shaft; but he would do away with all traps whatever, and connect the closet apparatus with the drains, which he would ventilate thoroughly to the outer air. He commended Pearson's valve ventilating apparatus and Pott's system, and recommended the ventilation of sewers themselves at proper intervals. In discussing the vexed question of the disposal of sewage, he maintained that none of the best-known methods was suitable for all cases, although much could be said for each of them. No doubt, however, when ground could be acquired on a light porous soil, the combination of irrigation and downward intermittent filtration was by far the best method of disposing of the sewage of towns and the prevention of the pollution of streams. Mr. Adam Scott, of London, followed with a paper on "Liernur's system of Pneumatic Drainage," in which he claimed for it the means of preventing the formation of sewer gas and the production of sewer diseases, and that it would purify all sewer-water, while the revenue to be derived from the utilization of the products of the drainage would more than pay the cost of the works.

SCOTTISH INSTITUTION OF ENGINEERS AND SHIPBUILDERS. GLASGOW, NOVEMBER.

THE PRESIDENT, Mr. H. R. Robson, in the chair.—The first paper read was by Mr. M. Prior, Sheffield, on "Buckley's Patent Compensating Metallic Piston." It was claimed on the part of the invention that it was simple in construction, really self-adjusting, the elasticity being equally distributed over a great number of points, and acting both vertically and horizontally, it was made to retain its efficiency longer than any other piston. The friction was reduced to a minimum, so as to insure steam-tightness, the first cost being in many cases saved in three months by the reduced consumption of fuel alone. One of the pistons had been in use for a period of eighteen months in an engine where the pressure of steam used was 90 lbs. per square inch, another had been working continuously for three years under a pressure of 65 lbs. of steam, and one had been working for five years without the elasticity of the packing giving way in the slightest. It was stated, in answer to a question, that one piston had been in use for two and a half years that was 4 feet in diameter, and that Messrs. Buckley & Co. were preparing to make them much larger. Hitherto these pistons have been almost exclusively in use for land engines, but they are now in demand among the marine engineers on the Clyde and elsewhere. An interesting discussion followed the paper, the speakers being the chairman, Professor James Thomson, C.E., Mr. Alexander Morton, and Mr. J. L. K. Jamieson (of John Elder & Co.). The concluding paper was by the Secretary, on "The Strength and Fracture of Cast Iron."

NEW-YORK ACADEMY OF SCIENCE.

AT the meeting of the chemical section of this Society, held December 13th, Prof. William Falke described

A NEW PHOSPHIDE OF SILVER.

This new salt has the composition represented by the formula Ag P. It is prepared by dissolving ten grammes of nitrate of silver in 150 c. c. of water, and adding to this 1.818 grammes phosphorus dissolved in 5 c. c. of bisulphide of carbon. It forms a black powder, which can be dried by gently heating it in a current of dry carbonic acid gas. When dry it is sometimes pyrophoric, taking fire spontaneously when thrown into the air. At a temperature above 212° F. it decomposes, all the phosphorus is given off, and pure metallic silver is left in beautiful dendritic forms. Prof. Falke recommended the use of this process for the determination of silver in quantitative analysis, as the silver is completely precipitated as phosphide, is then easily washed by decantation, and on gently igniting is converted into metal, and can be weighed as such.

Mr. Henry Newton, E.M., gave a description of the method employed for the manufacture of iron directly from the ore in Japan. One of the peculiarities is the furnace employed, which has thirty tuyeres, is only six feet high, and must be taken down to remove the loop of wrought-iron produced. Some cast-iron is also formed in the same furnace, and run off by tapping before destroying the furnace. The process, of course, is not an economical one.

Dr. H. C. Bolton exhibited some specimens of a

NEW KIND OF TEST PAPER.

Strips of white paper, when soaked in a solution of coralline, become exceedingly sensitive to the action of alkalies, and form an excellent substitute for red litmus paper. On immersing a slip of almost colorless coralline paper in a very dilute alkaline liquid it at once acquires a beautiful red color. Acids turn it yellow, and as the color is less striking, it is not proposed by its inventor, Dr. E. Waller, to make use of it for acids, but only for alkalies.

Prof. Seeley called the attention of the Academy to Mr. Edison's discovery of a new force, and was requested by them to investigate and report on it.

THE INSTITUTION OF CIVIL ENGINEERS.

AT the first ordinary meeting of the session, November, a paper was read descriptive of "The Manora Breakwater at Kurrachee," by Mr. W. H. Price, M.Inst.C.E.

This breakwater was described as the most important feature of the Kurrachee Harbor works, designed by the late Mr. James Walker, past president Inst.C.E., assisted by Mr. W. Parkes, M.Inst.C.E. Kurrachee, the natural port of Scinde and of the Punjab, was rendered unfit for any except native craft on account of the bar. The new direct entrance channel, which now gives 20 feet at low water, and, with the breakwater, renders the harbor accessible to vessels of the largest class, greatly saves the use of steam-tugs, and allows of the regular arrival and departure of the mail-steamers. The breakwater, projecting from Manora Point for a length of 1503 feet into five fathoms of water, shelters the entrance from the southwest monsoon seas, and prevents the formation of a bar. It consists of a base of rubble-stone bevelled off to 15 feet below low water, on which concrete blocks weighing 27 tons were set on edge, leaning back at a slope of 3 inches to 1 foot, and without bond, two blocks forming the width and three the height, which were respectively 24 feet, the top being about the level of high water. The rubble base was deposited from native boats, and was levelled for the superstructure by helmet divers. The cost

of the breakwater alone was £93,565, or £62 5s. per lineal foot. The work had been carried on in the Bombay Public Works Department, by the author and his assistants, advised by Mr. W. Parkes, as consulting engineer, and without the employment of any general contractor. The entire scheme of harbor improvements, of which this is only the most important feature, comprises a stone groyne 8900 feet long, dredging and removal of rock, a new tidal channel, and a screw-pile bridge, 2780 feet of embankment, 1400 feet of jetty and quays, at a total cost of £450,000. The council of the institution have issued a list of subjects for original communications for the session 1875–76. These relate to the flow of fluids, liquid and gaseous, the manufacture of Portland cement, concrete, the application of steam machinery for excavating, stone quarrying, the manufacture of iron and steel, forging by percussive machinery and by the hydraulic press, construction with steel and other metals, the construction of buildings to resist fire, street tramways, the foundations of bridges, the construction of iron bridges, canal locks, dock gates and caissons, rock drills, tunnelling machinery, railway rolling-stock, the water supply of towns, the disposal of sewage, the history of rivers, river and canal towage, furnaces, high-pressure steam-boilers, the best practical use of steam, steam jacketing, marine-engines, portable steam-engines, the conveyance of coal, pumps for raising water, wind or water as a motive power, gas as a motor, the removal and storage of grain in bulk, lamps for using with mineral oils, the output and distribution of coal for consumption, machinery for deep coal-mines, the ventilation of railway-tunnels, compressed air as a motive power, the dressing and smelting of metallic ores, the manufacture of artificial fuel, wood-working machinery, pneumatic telegraphs, and recent progress in telegraphy. For approved papers on these and kindred subjects, the council are prepared to award medals and prizes, having at their disposal for this object special funds producing in the aggregate an annual income of nearly £460.

GEOLOGY.

WHATEVER tends to popularize geology is worthy of commendation from all interested in mining, and when the task of writing popular treatises is undertaken by such undoubted authorities as Dana they can not be too extensively read. In his new volume* Prof. Dana addresses himself to the general reader, and has, therefore, given an excellent outline of the science in language which can not fail to prove attractive. He remarks that geology is eminently an out-door science; for strata, rivers, oceans, mountains, valleys, volcanoes can not be taken into a recitation-room. Sketches and sections serve a good purpose in illustrating the objects of which the science treats, but they do not set aside the necessity of seeing the objects themselves. The reader who has any interest in his subject should, therefore, go for aid in his study to the quarries, bluffs, or ledges of rocks in his vicinity, and all places that illustrate geological operations. At each locality accessible to him he should observe the kinds of rock which there occur, whether they consist of layers or not; and their positions, whether the layers are horizontal—the position they had when made; or whether inclined, a slope in the beds being evidence of a subterranean movement which takes place in mountain-making. Geology teaches that much the larger part of the rocks that consist of layers were made through the action of water; and if such rocks be accessible, it is well, after learning the lessons of the book, to look among them for evidence of this mode of origin, either in the structure of the layers, in the nature of the material, in markings within the beds, or in the presence of relics of aquatic life, such as shells, bones, etc. If some of the layers in a bluff consist of sandstone, others are pebbly, others clayey, and one or more are of limestone, the kinds of changes in the waters that took place to produce so varied results should be made a point of investigation.

In the same way Prof. Dana points out the desirability of examining excavations, beaches, cliffs, sand-flats, coral reefs, and any thing else from which facts can be ascertained, and he carefully explains how these examinations can be best made. After defining what geology is, he conveniently divides his subject into three parts, first dealing with rocks or what the earth is made of, describing the more important minerals, the kinds of rocks, and the structure of rocks; then treating of causes in geology and their effects, including the making of rocks, of valleys, and of hills and mountains, and the attendant effects; whilst the third division is devoted to historical geology. In the latter section he explains that the plants and animals that lived in the successive periods left their relics—that is, stems or leaves, shells, corals, bones, and the like—in the mud or sand of the sea-bottom, sea-shore flats, and beaches, and in other deposits of the era, and these sand-beds and mud-beds are now the rocks of the period. Hence, in the rocks of one era we find different relics or fossils from those of the preceding or following era. Geologists have ascertained the kinds that belong to the successive rocks or eras of the world, so that if they come upon an unknown rock with fossils in a country not before studied, it is only necessary to compare the fossils found with the lists already made out. For a very long part of early time, after life was abundant, there were no fishes in the world; hence the discovery of a fossil fish in a bed of rock is evidence that the bed does not belong to the formations of that early time, but to one of some later period.

After the first appearance of fishes the kinds changed with the progress of time, so that if in the case of our discovery we can ascertain the tribe to which the fossil fish we have obtained belonged, we can then decide approximately the age of the rock which afforded it. No herring, cod, or salmon are known to have existed until near the last of the geological ages, and if the species turned out to be related to these we should conclude that the rock was among the later in geological history, and a determination of the species might lead to the precise epoch to which it pertained. Bones of beasts of prey, cattle, and horses are found only in rocks of the last two geological ages. Thus, owing to the succession of life on the globe, the geologist is enabled to arrange the fossiliferous rocks in the order of their formation—that is, the order of time. If a stratum in one region contain no fossils, or if its fossils have been obliterated by heat-producing metamorphism, the stratum is traced by the geologist to another region, with the hope of there discovering fossils, or at least finding them in an underlying or overlying stratum. In this and other ways doubts are gradually removed, and the true succession in any region is made out.

The volume is altogether admirable, the style is attractive, and the printing and illustrations all that could be desired, so that it may fairly be anticipated that the number of readers will be large. There is probably no other work from which so clear an insight of the leading principles of the science could be as readily obtained, and certainly none which conveys the information in so pleasant a manner.—*Mining Journal.*

* "The Geological Story Briefly Told: an Introduction to Geology for the General Reader and for Beginners in the Science." By JAMES D. DANA, LL.D. New-York and Chicago: Ivison, Blakeman, Taylor & Co.

BOTANY.

MOVEMENTS AND HABITS OF CLIMBING-PLANTS.

MR. DARWIN divides climbing-plants into four classes: those which twine spirally round a support, and are not aided by any other movement; those endowed with irritable organs, which, when they touch any object, clasp it; those which ascend merely by the aid of hooks; and, lastly, those which do so by means of rootlets. Neither of the two latter classes, however, exhibit any special movements, and the principal portion of Mr. Darwin's work is therefore devoted to plants belonging to the first two classes. These four principal modes of climbing are generally characteristic of distinct plants, though *Bignonia Tweediana* is a remarkable instance, inasmuch as it combines four different modes of climbing—namely, twining, leaf-climbing, tendril-climbing, and root-climbing. When plants climb by means of irritable organs, such organs may consist of modified leaves, branches, or, as in the case of the vine, of flower-peduncles: but these different classes sometimes graduate into one another. It is very interesting to observe that the homological nature of a tendril seems to make no difference in its mode of action. We should indeed, I think, be disposed to expect this from the interesting fact that climbing-plants are found among so many distinct orders of plants. Lindley divides phanerogamic plants into fifty-nine alliances, of which, without counting hook or root climbers, no less than thirty-five include true climbing-plants, to which a few cryptogamic forms must be added. The advantage to many plants of becoming climbers is very obvious, since they can in this manner reach the light, and expose a large surface of their leaves to its action and that of free air, with comparatively little expenditure of organized matter; and it is interesting to observe that, as Mr. Bates has pointed out, the tropical forests of America, which are so characterized by the abundance of arboreal mammals, also contain a large number of climbing-plants.

The power of climbing appears to depend upon the curious rotatory movements performed by the growing plants. Hofmeister has observed that the shoots and leaves of all plants, while young, move after being shaken, and Körner also has noticed that the flower-peduncles of a large number of plants, if shaken or gently rubbed, bend to one side. This rudimentary power of movement has, in Mr. Darwin's opinion, been specialized and perfected in the case of climbing-plants; and he thinks that leaf-climbers were, in the first instance, twiners, and subsequently became capable of grasping a support, which would be a great advantage to them. However this may be, it appears clear that the curious rotatory movements which are performed by the growing shoots of climbing-plants, and which are sometimes in the direction of the sun, but more often take the opposite course, are essential to the power of climbing.

Of these rotatory movements Mr. Darwin gives a most graphic account. For instance, speaking of an asclepiadaceous plant, belonging to the genus *Ceropegia*, he says:

"I allowed the top to grow out almost horizontally to the length of 31 inches; this now consisted of three long internodes, terminated by two short ones. The whole revolved in a course opposed to the sun (the reverse of that of the Hop), at rates between 5 hrs. 15 min. and 6 hrs. 45 min. for each revolution. The extreme tip thus made a circle of above 5 feet (or 62 inches) in diameter, and 16 feet in circumference, travelling at the rate of 32 or 33 inches per hour. The weather being hot, the plant was allowed to stand on my study-table; and it was an interesting spectacle to watch the long shoot sweeping this grand circle, night and day, in search of some object round which to twine."

In some cases, the plants really behaved almost as if they were alive:

"Several times," says Mr. Darwin (p. 111), "I watched cases like the following: A tendril caught a thin stick by the hooks of one of its two extreme branches; though thus held by the tip, it still tried to revolve, bowing itself to all sides, and by this movement the other extreme branch soon caught the stick. The first branch then loosed itself, and, arranging its hooks, again caught hold. No other branches, as the tendril then stood, could possibly have touched the stick. But, before long, the upper part of the main stem began to contract into an open spire. It thus dragged the shoot which bore the tendril towards the stick; and as the tendril continually tried to revolve, a fourth branch was brought into contact. And, lastly, from the spiral contraction travelling down both the main stem and its branches, all of them, one after another, were ultimately brought into contact with the stick. They then wound themselves round it and round one another, until the whole tendril was tied together in an inextricable knot.'

It is also curious that tendrils which would thrive and thicken if they met with a suitable support, die and drop off like a leaf in autumn if they fail to find such an object of attachment. The sensibility of some tendrils is very remarkable. In one case Mr. Darwin found that a loop of thin thread, only $\frac{1}{32}$ of a grain in weight, caused a temporary flexure. In another a touch with a pencil, so gentle as only just to move a tendril borne at the end of a long flexible shoot, was sufficient to cause it to become perceptibly curved in four or five minutes: but it is curious that tendrils which are drawn across one another do not catch, nor are they affected by drops of rain. Mr. Darwin found in several plants that a shower from a syringe, which instantly caused the leaves of a Mimosa to close, had no effect upon the tendrils of a passion-flower; whereas a loop of thread weighing $\frac{1}{32}$ of a grain, which caused the tendrils to become curved, had no effect upon the leaves of a Mimosa; a fact which curiously shows how the sensitiveness has become differentiated in different plants. In Mr. Darwin's opinion, leaf-climbing plants were originally twiners, and tendril-bearers were originally leaf-climbers; and certainly the disposition of the climbing species in the different natural orders lends a strong support to this view. Gradations of structure also are very interesting. Thus, among leaf-climbers, in the *Fumariaceæ*, we have a most interesting gradation. The terminal leaflets of *Fumaria officinalis* are no smaller than the rest; in *Adlumia cyrrhosa* they are greatly reduced; in *Corydalis claviculata* they have become microscopical; and, finally, in *Dicentra* the tendrils have become perfectly characterized.

We have not space for more illustrations, but we trust that the facts above quoted will be sufficient to show the great importance of Mr. Darwin's work on Climbing Plants, and that its interest is by no means confined only to the student of botany.—*Ellen Lubbock, in The Academy,* 1875.

THE PNEUMATIC APPARATUS OF LONDON.

AT a recent meeting of the Institution of Civil Engineers, London, Mr. George Robert Stephenson, Vice-President, in the chair, the paper read was by Mr. R. S. Culley, M. Inst. C.E., and Mr. R. Sabine, Assoc. Inst. C.E., "On the Pneumatic Transmission of Telegrams."

The paper commenced with a short sketch of the history of the process, and gave a statement of the extent to which it had now attained. There were twenty-four pneumatic tubes in London, of an aggregate length of 17 miles 1160 yards—four tubes in Liverpool, three in Dublin, five in Manchester, three in Birmingham, and one in Glasgow. The London system was described. When the number of tubes became large, it was found necessary to simplify the valves and sluices, rendering them less automatic, but easier to keep in order, than the earlier apparatus. Lead was preferred to iron as the material for the tubes. An experience of twenty-one years had shown that with felt message-holders, or carriers, there was no abrasion of the metal, which became highly polished, and that the tubes were practically air-tight, the exhaustion in one, 1289 yards in length, occupying thirteen minutes in falling from 17.25 in. of mercury to atmospheric pressure, including the leakage from the valves. Iron had been used for two tubes, each 2610 yards long, but it was found to rust rapidly, and to wear out the carriers. In the Paris system the iron tubes did not rust, and it was suggested that the difference was due to the air in Paris being carefully cooled by water, and to the friction of the heavy carriers of iron covered with leather; while the air in London was used warm from the pumps, and the carriers were made as light as possible. The diameter adopted for the tubes was $2\frac{1}{4}$ in. as being large enough to carry the traffic with sufficient speed, and not so large as to require a costly volume of air. The process of laying and jointing the tubes was explained. The carriers were cylindrical boxes of gutta-percha, covered with shrunk drugget; their weight was $2\frac{1}{2}$ ounces. The traffic was regulated by electric signals. Stoppages were rare, and were cleared by filling the tubes with water and applying pressure. It had never been necessary to open a lead tube, except in cases of bad construction, or of external injury caused by workmen. The engines were on the Wolff principle, and in ordinary work expended 134 h.-p. The pumps were so arranged that each could be set to compress or to exhaust at pleasure, and the air-valves were fixed in sliding pieces, so that a defective valve could be quickly replaced.

The paper went on to show why a much more costly system of tubes and much larger engines were required in this country than in Paris, Berlin, or Vienna, where the pneumatic system was also in operation. On the Continent, with perhaps an exception as regarded the Paris Bourse, trains of carriers were run at fixed times, in Paris every quarter of an hour; but in England a message was never delayed—speed was the first requisite, and carriers followed one another as rapidly as possible. The tubes could not therefore, as a rule, serve more than a single station; stations could not be grouped in circles; but each tube had to be direct, and as short as possible. An opinion expressed during a former discussion of the subject, that pneumatic was more costly than electric transmission, was shown to be erroneous; for the total expenses of the former in London were barely two-thirds of the amount which would have been required to pay the salaries alone of the clerks needed under the latter, irrespective of the cost of wires and instruments.

Theoretical principles were next discussed. Formulæ were given for the mechanical effect performed by air in expanding, for the volume of denser air which entered the tube during the transit of a carrier, for the speed of carriers, for the times of transit, for the mean weight of a cubic foot of air both for pressure and for vacuum working, and for the work done in compressing and exhausting the air. The results of experiments followed. First special experiments on a tube 5523 ft. long, having an intermediate station; then on another tube 4227 ft. long, showing the close coincidence of the actual times of transit under various pressures, with the times calculated by the formulæ previously given. The experiments showed, also, that the speed of a carrier driven by compressed air was greater when the pressure was cut off after each transit; or, in other words, that there was a loss of speed when the air was kept constantly in motion. In the former case, the carrier started into a comparative vacuum at atmospheric pressure; in the latter case, into dense air; consequently the higher the pressure employed, the greater the difference in speed—with 14 lbs. pressure the difference was 6 per cent. In working by vacuum a reverse result obtained. The experiments likewise demonstrated that the pressure fell to zero at the distant end almost regularly with the length, but not quite so. With an initial pressure equal to 18 in. of mercury, the pressure at the centre of a tube 8454 ft. long was 9.75 in. instead of 9 in., and in every case there had been a higher pressure at intermediate points than that due to their position, when the fall of pressure was represented by a straight line. This result was attributed partly to the inertia of the air, partly to friction. The experiments also showed that when compressed air was admitted into a long tube or the air was pumped out of it, a sensible time elapsed before the permanent condition of the air pressure was established. In a tube 5523 ft. long this interval was forty-five seconds for the end next the air-pump, and about seventy-five seconds for the centre of the tube. The temperature of the air issuing from a tube was not lowered to an extent corresponding with its expansion in the tube, because it gained heat from the soil in London; but in Berlin, where the tubes are bedded in dry sand, the theoretical temperature was more nearly attained. Comparing a 3-in. tube with a $2\frac{1}{4}$-in., it was shown that more than double engine power gave only 16 per cent higher speed in the larger tube, so that any increase of diameter above that actually necessary to carry the traffic in the required time was attended with unnecessary expenditure. Again, by doubling the pressure, only 30 per cent in time was saved, but thrice the engine power was needed. In two tubes, each 1000 yards long, one 3 in. and the other $2\frac{1}{4}$ in. in diameter, by working the larger with a pressure of 5 lbs. and the smaller with one of 7 lbs. the transit was made in nearly equal times, while the engine powers were 2.6 h.-p. and 2.1 h.-p. respectively. The smaller tube at the higher pressure was therefore the more economical. The tubes should, in consequence, be as small as possible. The relative economy of working by vacuum, or by pressure, was then considered, to determine at which end of a tube, required for traffic in one direction only, the engine should be placed. It would at first sight appear that vacuum would be less expensive, because there was less weight of air to move than when using pressure. But as the rarefied air gained heat from the tube as it passed along, the volume which must be removed by the pump was greater than it would otherwise be; so that practically the cost of the two systems was the same.

RELICS OF STRANGE PEOPLES.

IN the valleys of Bolivia, South-America, there now remain about two hundred thousand souls, the remnant of a vast tribe which once overran nearly all of the western portion of the continent. Their ancestors migrated from the north at some unknown period, and on a sacred island in Lake Titicaca established a centre of government and religion. The Aymaras—for such is the name of this disappearing people—were skilful workers in gold and silver, learned in astronomy and in the arts of music, and painters and builders of no mean ability, as the great monuments still in the vicinity of Titicaca abundantly testify. As the Incas of Peru grew in power, so the Aymaras succumbed, until at last they gave way to their conquerors, and became as they are now, half ignorant tillers of the soil. The curious mummy which is represented in the annexed engraving, Fig. 1, was one of the ancient race, and was exhumed from the strange tombs which still exist near Lake Titicaca. These tombs are large, square buildings, with a single opening, through which the body was introduced, and in each receptacle twelve corpses were placed in sitting posture, habited in their clothes. The antiquity of the mummy represented is attested by the shape of the head, which resembles that of the Hottentot African. The peculiar conical form was, however, artificially produced by bandaging the head during infancy, the process being analogous to that followed by the Flathead Indians, of this country, for flattening the frontal bones of the skull. The Aymaras are now Christians, and have a queer religious ritual which is a blending of Roman Catholic rites with remnants of barbaric customs. In ancient times they worshipped the sun, which they supposed rose from the sacred island in Lake Titicaca, and regarded the bodies of their dead as lesser divinities.

The head of a Tasmanian Indian, drawn from a bust modelled from life, is represented in Fig. 2. The original race of Tasmanians has recently become extinct, and the individual whose portrait is here given was one of seven survivors. This strange people are generally described as samples of the lowest form of humanity. They lived in caves or hollows in the hills, and it was only on elevated plateaux that any kind of a shelter was attempted. The object of the mere shed which in such localities was constructed was more to protect the fire than the inmate, for it was little more than an inclined semicircular wall. Ethnological authorities who have carefully studied the history of the Tasmanians, affirm that no individual of the race has ever been found who could remember any time when fire was artificially produced by any one of his tribe. Even the North-American Indian's practice of rubbing two pieces of wood together, and getting a fire through friction, was utterly unknown. Hence the importance of a perpetual fire was so keenly felt that it was never allowed to die away, and during periods of migration the females were especially charged with the duty of looking to the firebrand and keeping it burning. Like the Indians of America, the Tasmanians believed in a hereafter, in the

FIG. 3.

shape of a happy hunting-ground. The sole mythological personage devised by them was a spirit who was disposed to evil after nightfall, and they were curiously destitute of any ideas relative to witchcraft or fetishism. Their pursuits were simply brute-like—searching for food, their relaxation, dancing. They had no medicine-men, and burned their dead, never pronouncing the names of the latter after incineration, through a superstitious fear of evil therefrom, but always carrying with them a fragment of human bone or skin as an amulet against disease.

The head represented in Fig. 3 exhibits the strange habit of tattooing, peculiar to the New-Zealanders, which, under the civilizing influences of English rule, is gradually becoming abandoned. Tattooing on the face, as here shown, the New-Zealanders term *moko*, and on the body *whakairo*; the term tattoo being unknown, although it is of Polynesian origin. The men tattoo their faces, hips, and thighs; the women their upper lips. The figures are alike among persons of the same tribe. The pigment used is charcoal made from kauri gum and other vegetable substances. Under the skin the charcoal looks blue and grows less dark in the course of years. Previous to the introduction of Christianity, the people were fierce and savage, and cannibalism was universal.

Fig. 4 is the section of a tomb opened near Valloby, in Denmark, in which was found the body of a barbarian of Northern Europe, together with a variety of Roman articles of date of manufacture probably three or four hundred years after Christ. The sepulchre thus forms a curious link between the civilization of Rome and the barbarism of the North. Goblets of silver were mingled with vases of rude pottery, and finely-worked armlets (Fig. 5) of gold lay side by side with rough bronze ornaments. The head of the body was turned to the north, and the inclosing excavation was hollowed from a mass of small stones, above which a mound of earth encircled with large boulders was erected.

THE ELECTRO-MAGNET.

AT the ordinary meeting (November) of the Manchester Literary and Philosophical Society, Dr. R. Angus Smith in the chair, a paper was read by Professor Osborne Reynolds on "The Principle of the Electro-Magnet constructed by Mr. John Faulkner." Mr. Reynolds stated that the magnet which formed the subject of his paper consists of a soft, iron bar with a flat plate attached to one end and surrounded by a coil of wire in the same way as the ordinary electro-magnet. Outside this coil is placed a tube of soft iron of the same length as that portion of the in-

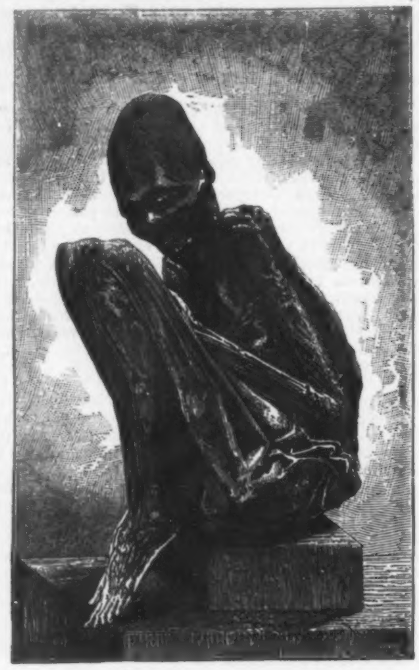


FIG. 1.

terior bar which projects beyond the plate; this tube has flat ends, one of which is in contact with the plate, while the other comes up flush with the end of the bar, so that a plate or keep placed over the end is in contact with both the bar and the cylinder. The magnet is excited in the ordinary way, by connecting the ends of the wire which forms the coil with the poles of a battery. When thus excited this magnet exhibits certain peculiarities as compared with a common mag-

FIG. 2.

net. In the first place, the magnetic field is very limited: being confined to the space in front of the open end of the tube, there is little or no magnetism along the tube or at the closed end. The magnet retains its keep with greater force than the simple bar. Mr. Faulkner has some magnets of this kind which retain the keep with one hundred times more force when the outer tube is on than when it is removed. The ratio of these retaining powers appears, however, to depend on the relative diameters of the bar and the tube; the larger the bar in proportion to the tube, the greater is the difference. Some magnets, made especially to test the relative powers, give an increase of only double as compared with the simple bar-magnet. This magnet has a greater sustaining power than the horseshoe magnet. This was shown by putting tubes round the poles of a horseshoe magnet, by which

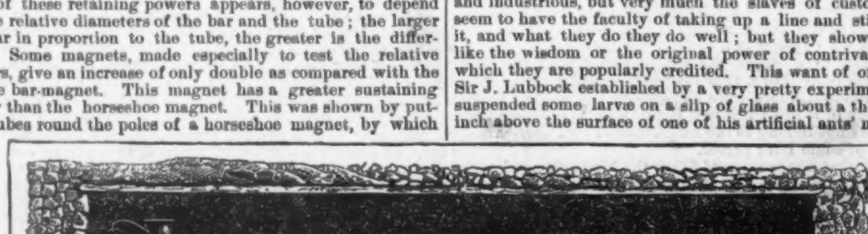


FIG. 4.

means it was made to sustain greater weights than it would without the tubes. The object of the paper was to suggest explanations of these phenomena. They were attributed to three principal causes. (1) The tube surrounding the bar unites the poles and converts the magnet into a kind of horseshoe magnet, the ends of the tube having the opposite polarity to those of the bar. If this were all, however, this magnet would not have any advantage over the horseshoe magnet. (2) The close proximity of the tube to the bar enables one pole to exert greater inductive action on the other than in the case of the horseshoe form. (3) The electro-magnetic action of both sides of the coil is utilized in the same manner as in the astatic galvanometer. The current converts the tube into a magnet of opposite polarity to the bar, and hence these two magnets act upon each other by induction, which their relative positions enable them to do with the greatest effect. It appears from the researches of Dr. Joule that the larger the bar inside the coil, the less will be the intensity of magnetism exerted in it by the coil. While it may be shown that the smaller the tube—the closer it is to the coil—the greater will be the intensity of magnetism excited in it. Also the inductive action of the iron in the tube on that of the bar is inversely proportional to the square of the distance between them. Hence it follows that the effect of using the outside as well as the inside of the coil must increase rapidly as the diameter of the bar approximates to the internal diameter of the tube. After the reading of the paper Mr. Faulkner exhibited some of his magnets; and by means of iron-filings scattered on sheets of paper produced some very beautiful diagrams illustrating the effect of the outside tube on the magnetic field.

THE DIGESTIVE MOVEMENT IN PLANTS.

THE following account of this movement is that given by Dr. Darwin in his late work:

"It opens up to us the secret of many of the so called animal motions. The interior of each cell is filled with, or rather is composed of, a mass of protoplasm. This at rest and in health is more or less uniform in character; but being irritated or excited, it becomes cloudy from the formation of granules, and these granules, in accordance with their ordinary laws, tend to aggregate into a spherical mass, leaving a clear ring of moving protoplasm around. This ring also disappears, and now there is but one central protoplasmic mass, undergoing all manner of changes of shape, such as we are wont to see in free-moving leucocytes. Cell after cell is thus affected in a moment's time, until, under the influence of the combined movements, the whole tentacle obeys the impulse, and closes in upon its prey. This continues while the gland-cells are in an actively oxygenated state, but by and by ceases, the tentacles re-expand, the cellular masses of protoplasm are redissolved, and the cells fill with a homogeneous liquid."

THE HEALING ELEMENT IN ARNICA.

THE ingredient in arnica long supposed most important was *arnicine*, an amorphous bitter substance, almost insoluble in water, but freely soluble in alcohol and ether; or else the ethereal oil, which is also insoluble in water. For a variety of reasons, it is now probable that neither arnicine nor the oil, but *trimethylamine*, an organic alkali, is the really useful constituent of arnica.

Trimethylamine, C_3H_9N, is a clear, colorless fluid, very volatile and freely soluble in water, alcohol, and ether.

For external bruises and cuts, arnica is, undoubtedly, very

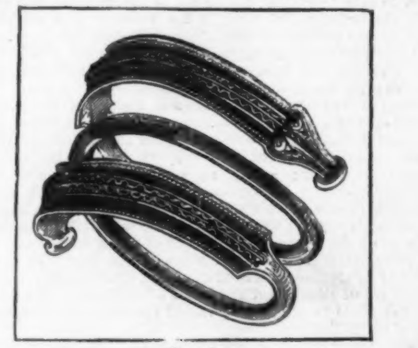


FIG. 5.

useful; and the mischances that have attended its use have probably resulted from the fact that the tincture, containing arnicine and the volatile oil, has been employed. The infusion or decoction alone should be used, and it would be better to give up employing all liniments and lotions in which the tincture is present.—*Medical and Surgical Reporter.*

[From London Examiner.]

SIR JOHN LUBBOCK ON ANTS.

SIR JOHN LUBBOCK has published some further experiments on ants and bees, which make serious inroads on the reputation of those exemplary animals. The sum of his experiments seems to be that the intelligence of the creatures is very much in proportion to the size of their brain matter, taken relatively to the size of their bodies. They are active and industrious, but very much the slaves of custom; they seem to have the faculty of taking up a line and sticking to it, and what they do they do well; but they show nothing like the wisdom or the original power of contrivance with which they are popularly credited. This want of originality Sir J. Lubbock established by a very pretty experiment. He suspended some larvæ on a slip of glass about a third of an inch above the surface of one of his artificial ants' nests, and placed some black ants on the glass with the larvæ. Within half an inch of the glass he placed some fine mould, so that if the ants had possessed much engineering skill they could in half a minute have constructed a bridge between the glass and their nest. Not only did they not do this, but the ants on the glass did not even risk the leap to the nest, which they could almost touch with their antennæ. They seized larvæ and leaned over the edge of the glass, and some of them got down on the backs of their fellows, but most of them travelled to the nest by a circuitous route of thirteen feet, along which was presently established quite a string of ants passing to and from the nest to the larvæ. Go to the ant, thou sluggard; but do not go to the ant, thou engineer.